PORTLAND CEMENT AND CONCRETE.*

BY HENRY FAIJA, A. M. I. C. E., ETC.

Portland cement concrete may be divided into two classes (1) that laid *in situ*—evidently embracing foundations of all kinds, dock, harbor, and sea walls, houses and other structures, of a monolithic character; (2) purpose-made blocks, embracing building blocks of all kinds, window sills and heads, pipes, paving slabs, chimney-pieces and ornamental panels, etc.

The production of a good, sound and economical concrete is dependent on the existence of a proportion between the large and small aggregate and the cement, in order that all interstices between the larger aggregate may be filled by the smaller aggregate and cement, so that each piece of aggregate is surrounded with cement; and as the cement is more expensive than the aggregate, no more cement should be used than is sufficient for this purpose. A concrete may thus be considered as composed of two parts, an aggregate and a matrix, the aggregate being the larger pieces which are united by the matrix composed of the cement and sand, or cement and the fine particles of the same material as the aggregate used; thus a concrete composed of shingle would have sand added, which would be formed into a mortar or matrix uniting the shingle; while in the case of a concrete composed of a crushed stone, the matrix would be composed of the cement and the stone dust, which would unite the larger pieces of stone.

The proportion of cement used to the aggregate must depend on the nature of the work for which the concrete is required, and the strength which it is desired to obtain, on the size and form of the aggregate, and on the proportion which the larger and smaller aggregate bear to each other, as well as on the nature of the aggregate used. To determine this proportion, it is usual to fill a bucket or other measure with the larger aggregate, and then fill it up with water. The quantity of water in the bucket will represent the amount of matrix necessary to make the concrete solid, the matrix being composed of the cement and fine aggregate, the proportions of which may be determined by the requirements of the case and the proportion of the fine and large aggregrate, which may be ascertained in a similar manner. For many purposes of concrete laid *in situ* twelve of aggregate to one of cement is sufficient, and the docks at Chatham have been principallyf ormed of concrete in this proportion, with the exception of the outer face, 9 in. or 10 in. thick, which is composed of a better concrete. It seems almost impossible that such a small proportion of cement should give the desired strength, but it must be remembered that if the larger aggregate is separated from the finer, the constructive strength of the concrete is represented by certain large aggregate united by a matrix or mortar which would be in the proportion of about five to one—a mortar which is strong enough for almost any purpose. This example shows the economy in the use of cement over a lime concrete, for whereas a lime concrete, for a foundation for instance, would have to be composed of at least one of lime to four of aggregate, a considerably stronger concrete would be produced with one of Portland cement to eight of aggregate, and the cost would be found to be much about the same; but as the cement concrete has a greater strength, a lesser thickness would be necessary, and consequently an economical result would be obtained.

The manufacture of concrete into building and other blocks is governed by the same laws that it is necessary to observe in laying concrete *in situ* —*i.e.*, the aggregates and matrix must be in proper proportions. There is, however, this difference, that except in case of very large blocks a smaller aggregate is used, and greater care is exercised in the operation of mixing. In harbor and dock work it is, of course, economical, whenever possible, to lay the concrete *in situ*, as the expense of moving and laying blocks is avoided; but in many instances it is not possible to lay concrete in this manner, and it becomes necessary to make the concrete in blocks, often, where the force of heavy seas has to be resisted, weighing as much as 100 tons each. The blocks are of necessity made in wooden molds, or boxes, which are removed when the concrete is sufficiently set; the blocks are then allowed to remain for several months until they have acquired sufficient strength to bear removal and to be placed in their position in the work. The manufacture of blocks of this size may be considered as the connecting link between the concrete laid *in situ* and the more finished examples of concrete, exemplified in the ornamental work, chimney pieces, and paving slabs already referred to. The manufacture of these is carried out in the following manner:

Where a concrete manufacturer has what may be called stock designs, the moulds would generally be made of iron or gun metal, capable of being easily taken to pieces and removed from the concrete when it is sufficiently set. By this means, though the first cost of the molds is considerable, they may for a practical purpose be considered indestructible. For work of an ornamental character, where there is much undercutting, plaster molds would probably be adopted by most makers. By the use of this material for monlds, the special designs of an architect can be carried out at a minimum of cost. For window sills and heads, sewer sections, paving slabs, etc., it is customary to use wooden molds, which may, however, be lined with iron if desired; for pipes, iron moulds are invariable used. The material, however, of which the molds are made, is simply governed by convenience. It would evidently be ridiculous to make an expensive mold if only a few castings were required from it, whereas if many pieces are required of similar design, it is equally evident that it would be economical to make a mold of such material that it would last uninjured until all required of it had been obtained.

To describe the manufacture of paving slabs will perhaps give a better idea of the way in which all high class concrete goods are manufactured, than what would of necessity be a desultory description of the entire industry; concrete paving slabs, moreover, can be seen and their advantages appreciated by all.

The best concrete paving slabs are made with an aggregate of either crushed granite, Kentish rag, or blast furnace slag, it being crushed so that it will all pass through a sieve having a three-eighth of an inch mesh; it is then carefully washed to remove all dirt and earthy matter, and is in this condition ready to be mixed with the cement, which is effected either in a mixing pan, such as has already been described, or with shovels on a concrete or ashphalt floor, in either case a minimum of water being used; the proportion being three or four of the aggregate to one of cement. When the concrete is gauged it is placed into the mulds, and either rammed down with beaters or shovels, or shaken down by being placed on a shaking table; it is then put on one side and allowed to rest until the concrete is sufficiently set to bear removal from the mold, which may be in perhaps forty-eight hours, When removed it is then put edge upward on a rack and left for several months, until it has attained sufficient hardness to be used for its intended purpose. In some manufactories, the hardening is slightly accelerated by placing the slabs when they are about a week old in a bath composed of one part of silicate of soda and about four parts water, where they are allowed to remain for six or seven days. Silica is a substance which has the peculiar tendency of leaving any base with which it is combined, in order to attach itself to another, thus, the silica which is in combination with the soda in the bath leaves the soda to attach itself to the lime in the cement, thus hardening it; but unfortunately, by this process the skin only of the concrete is hardened, a kind of case-hardening being effected, which, though it enables the block or slab to be more easily handled, prevents the induration or hardening of the interior. A more perfect process for accelerating the hardening of concrete has, however, lately been patented by the speaker, by which concrete made in the form of paving slabs, sills, ornamental panelling, etc., can be put to its respective uses when only two or three days old. Briefly described, the process is as follows: The concrete is made and placed in molds in the ordinary manner, but the molds are then placed into a chamber which is maintained at a moist heat of about 100 deg. Fahrenheit, which greatly facilitates the crystalisation or setting of the cement, and enables the concrete to be removed from the molds in the course of a few hours. The concrete is then immediately placed in a warm bath of about 100 deg. Fahrenheit, composed of one part of silicate and soda and twelve parts of water; the action of the silica in this instance is exactly similar to the action of the silica when used cold, with the difference, however, that the concrete being warm when placed in the bath, the solution immediately saturates to its very centre, and it is thus hardened throughout instead of only on the surface. All ordinary sized slabs and blocks need not be left in this bath for more than two or three days before they will have attained the strength of ordinary concrete three or four months old, as a proof of which the following results of tests are given:

RESULT OF TESTS.

Section 1½ in. by 1½ in.

The aggregate in each case being broken so as to pass a sieve having a quarter of an inch mesh, and gauged in the proportion of four of aggregate to one of Porland cement.

	2 days.	3 days.	4 days.
	lb.	lb.	lb.
Kentish rag	787	911	1,170
Granite	1,068	1,462	1,606
Ordinary concrete, three months old			1,402

The process has only just been perfected, and the speaker ventures to think that it is worthy of the consideration of manufacturers of concrete, as the slabs or blocks may be put to their respective uses in three or four days from gauging; the great expense of stock, storage room, and the multiplicity of molds saved. On the table are one or two small tiles, two inches thick, which were gauged the day before yesterday, and are composed of three-parts aggregate and one part cement.

Concrete may be made to assume almost any desired color, either by means of the color of the aggregate, or by the addition of a very small percentage of a mineral coloring matter. Opinion, however, at the present moment is somewhat divided on this matter, some maintaining that the color should be due entirely to the aggregate, on the basis that all chemical matters have a detrimental effect on the strength of the concrete; others maintain that for ornamental purposes, where great strength is not of the first importance, the small percentage of coloring matter necessary to produce the desired artistic effect is so small that the loss in strength is inappreciable and of but small importance. Perhaps the latter argument is the soundest; the color obtained by means of the aggregate alone must of necessity be spotty and uneven, while a mineral coloring matter gives an even shade throughout, which may be toned to suit any class of architectural design.

Concrete of this class will bear cutting and carving with a chisel like stone, and it is, therefore, possible to produce it in any artistic form with the necessary economy which must accompany the production of the design as a casting in a rough form. The materials which concrete has to supersede are stone, brick, terra-cotta and similar ware. When used in large quantities, the economy in using concrete over stone is self-evident, and for architectural and artistic effect its advantages have just been alluded to. With respect to brick it certainly would not be economical to make concrete blocks the size of bricks, but when used in larger sizes its economy is assured, as is exemplified by the concrete houses which have been built; in fact, the blocks may be cast hollow for purposes of ventilation and dryness, as well as having the further advantage of lesser weight for carriage. The blocks also being perfectly true in form, enable the mere setting of them being carried out much more economically than in the case of bricks. This same advantage of trueness in form at once shows the superiority of concrete over terra-cotta in the matter of artistic designs. Nobody can look at a terra-cotta building or a building having its architectural ornamentation in terra-cotta without admiring the general effect and the beautiful color of that material, and at the same time cannot help thinking what a pity it is that in many instances the delicacy of the design and the constructive strength of the building is marred by the more or less twisted and contorted form of some of the pieces. It having been shown that it is possible to produce concrete of any desired color and form with the certainty of that form being absolutely true in its design, it cannot but be allowed that concrete has a great future before it as a substitute for terra-cotta.

*The Testing and Properties of Slow-setting or Portland Cements.**

BY — BARREAU.

The author reviews the different methods of manufacturing and testing Portland cement. Attention is directed to the papers of Mr. J. Grant †, many of whose tables are reproduced in full. Several analyses of English, French and Belgian cements are given, the chemical composition of which appears to differ but slightly. The oxide of iron, sometimes present in considerable proportions in cement, is regarded as an inert substance; while the magnesia, in which some German cements are rich, is supposed to act in the same manner as lime when exposed to the action of water. Sulphuric acid, present of sulphate of lime, retards setting, and should not occur in appreciable quantities. Chemical analysis is considered indispensable for checking the composition of the cement before burning, the habit of relying upon practical tests alone, even if carried out by a skilled workman, being severely condemned. Fine grinding of the burnt cement is of the highest importance from an economical point of view. The coarse grains are of no more value than sand during the hardening process, and it has been found that their composition is the same as the finer and more active particles. It follows that it is only possible to obtain a thoroughly good, energetic cement by fine grinding. The question of cost, must, however, be taken into consideration. The cement should be passed through dressing-machines, and that which they reject should be reground. Although storing the cement may be advantageous when it contains a free lime, it is not considered necessary with a cement free from this defect, but in practice it has been found that cements used fresh do occasionally give unsatisfactory results, while with stored cements no

* Paper read before the Southend Mechanics' Institute on the 19th February, 1883.

* From an abstract of a paper in *Annales des Ponts et Chaussées*, for August 1882.

† Minutes of *Proceedings* Inst. C. E., vols. xxv., p. 66, and xxxii., p. 266.

such bad results have occurred. In France the net weight of a cask of cement varies from 170 to 190 kilograms (375 to 419 lbs.), while the sacks contain 50 kilograms (110l bs.) In Germany the official net weight is 170 kilograms (375 lbs.) for a cask, and 60 kilograms (132 lbs.) gross, for a sack.

A chemical test of Portland cement can rarely be carried out in practice, on account of the special skill required, but a test is proposed for ascertaining the amount of free lime in a cement. A weighed quantity of the sample is placed on a sieve, and water poured over it. The liquid is caught in a graduated tube, to the bottom of which the fine particles of cement sink, while the free lime is said to float above the cement as a kind of "laitance."‡ In the specification for the cement used in Boulogne harbor works, the maximum of sulphate of lime was fixed at 1 per cent. A table is given showing the composition of particles of the same cement of different degrees of fineness. The fine and coarse particles ppear almo it identical. Vicat's needle is still used in France for determining the time of setting. At Boulong the weight affixed to the needle was 300 grams (10.5 ozs.) while at Dunkirk 1.530 kilogram (3.37 lbs.) was considered necessary. Salt water was found to retard the setting of cement with which it was mixed, and a low temperature had the same effect. The crushing strength of cement can rarely be ascertained accurately, on account of the difficulty of making the briquettes perfectly regular and of insuring absolute contact. It has, therefore, been found advisable to use the tensile test as a criterion of the quality of cement. In France the briquettes are usually made of neat cement, and at Boulogne were tested at two separate intervals of forty-eight hours and 120 hours. Greater importance is attached to the second test, which is the equivalent of the English seven-day test. The breaking-section of the briquette is 0.04 meter by 0.04 metre (1.57 in. by 1.57 in.). Uniformity of temperature is insisted upon in the room where the briquettes are kept during the hardening process. A number of tests were made at Boulogne from 1878–1880 with different mixtures of fine or coarse sand, with varying proportions of cement. In each case the coarse sand made the stronger mortar. A graphic representation of these tests shows that in many cases there was a diminution in the strength of the mortar between eighteen and twenty-one months, after which the increase continued again.

In an appendix to this paper the specification for the cement for Boulogne harbor is given. The residue on a sieve of 180 meshes per lineal decimeter (45.7 meshes per lineal in.) must not exceed 10 per cent. of the volume tested. Any sample which, at a temperature of 15° Centigrade (59° Fahrenheit), when mixed with sea-water will support, after the lapse of half an hour, a needle with a point of 1 millimetre square (0.00155 square in.), weighted with 300 grams (10.5 ozs.), is to be rejected. The average tensile strength of the briquettes, after forty-eight hours' immersion in sea water of 10° to 15° Centigrade, is to be 7½ kilograms per centimeter square (106.6 lbs. per square in.), and in one hundred and twenty hours, 12¼ kilograms per centimeter square (177.8 lbs. per square in.)

‡ This test is founded on the assumption that the "laitance" from Portland cement consists of free lime, whereas its analysis indicates that alumina and silica are its chief constituents, free lime being soluble in an excess of water.

MODERN ORDNANCE.

From Engineering.

Improvements in gunpowder and an advance in knowledge relating to the laws governing its combustion have formed the basis upon which the development of ordnance during the last few years have rested.

The great difficulty of the moment is to foresee any finality to this development, which is so rapid that the best weapon of any class at the present moment may be found ere a year passes to be comparatively obsolete.

To obtain clearness of ideas on any subject, and especially on that relating to the action of fired gunpowder, it is desirable to generalize as far as the nature of the question admits, and with this view we lay down the following as axioms, the truth of which, we think, will be universally admitted by those who have carefully studied the subject. The action of powder when fired in any piece of ordnance is governed by four principal conditions: 1. The nature of the powder itself. 2. The forms and proportions of the chamber in which it is burnt. 3. The resistance to motion of the projectile, caused by its weight only, or in addition by any artificial means of retardation. 4. The position in which the vent causes the cartridge to be ignited.

To understand fully the revolution in ordnance caused by improvements in the nature of the gunpowder used (condition 1) we must take a brief survey of the changes which have occurred since rifled guns were first introduced, and in doing so, we propose to confine our remarks chiefly to this country.

The close of the smooth bore era, about the year 1859, found our magazines both at home and abroad filled with vast quantities of cannon powder known as L. G., or large grain. It was of a very quick burning violent nature, and the methods of testing the various lots or brands before passing it into the service were of the roughest description. Consequently it was quite unreliable, and similar charges gave very dissimilar results both as to pressure and velocity. It was clearly even more unsuitable for heavy rifled guns than for smooth bores, in which the resistance to motion of the spherical projectile was small, and where a free escape by windage over the shot considerably eased the pressure set up.

The first attempt to produce a satisfactory powder for rifled ordnance resulted in R. L. G., or rifle large grain. This differed from L. G. in being larger in the grain, more highly glazed, and in having more care bestowed on the testing of the various brands. It was a much better powder, but still far from being what was required. When fired in anything like large charges it gave excessively high pressures, due to the fact that it was, owing to its low density and small grain, almost entirely converted into gas while the movement of the projectile was still inconsiderable. These high pressures kept the charges small compared to the weight of the shot, since further increase of charge would have endangered the safety of the gun. The danger of high pressure suddenly applied is intensified by the fact that time is not allowed for the wave of pressure generated to extend itself through the mass of metal surrounding the bore, and whatever precautions are taken in manufacturing, these portions of the gun adjacent to the powder charge are liable to be unduly strained. The smallness of the charges with powder of this class prevented high muzzle velocities, as the volume of gas generated was small, and after the first severe blow was over the pressure fell off very quickly, because of the increasing space which the gas had to fill as the shot traveled up the bore.

Experiments abroad and in this country about the years 1867 and 1868 brought clearly to the minds of British artillerists the fact that the use of R. L. G. or *poudre brutale*, as it was called by foreigners, heavily handicapped our guns in competition with foreign ordnance firing a powder of a slower nature and therefore more suited to the production of high velocities with moderate pressure. The result of the experiments above referred to was the provisional introduction of pellet and finally of pebble powder, the relatively mild action of which is partly due to its increased density. This was a great step in advance, but it is a matter of regret that pellet powder, in which the grains were all of a definite size and shape, was not adhered to in place of pebble, which consists of grains about the size of hazel nuts and of rough and irregular form. Probably manufacturing reasons had much to do with the final decision, and the importance of having in each cartridge of given weight a definite amount of surface to ignite (which could only be done by making the grains of precisely the same dimensions and weight) was not fully appreciated.

The guns also, designed as they were, with very short bores to meet the requirements of the navy, and for a quick powder, were not adapted to give any very improved results with the use of a slower burning charge. The chief gain in the introduction of pebble powder was a great reduction of pressure with a moderate increase in velocity. In fact, as far as we understand, the attempt to increase the powers of the guns of 1868-70 which still remain as our service weapons, by the use of larger charges of a slower burning powder than pebble, has met with no very encouraging results.

The introduction of the 38-ton and 80-ton guns into the English service, together with the researches of the Committee on Explosives, resulted in the employment of P^2, a powder of about the same density as pebble, and formed of 1½ in. cubes. These guns had bores much longer proportionately than any that had preceded them in our service, and were therefore more suited to the use of such a powder. Pebble had proved itself also much too violent when used in charges of 100 lbs. or upward, and P^2 had still some of the defects of pebble as regards non-uniformity of size of the grains, but the limits of error in proof were made much narrower, and the various brands could be relied on to furnish much more uniform results than was the case with any service powder of earlier date. For many years previous to the introduction of P^2 into our service, which occurred about 1876, the powders employed in foreign heavy guns, notably in Germany and Russia, had been of the nature known as prismatic, that is to say, each grain was a prism, generally hexagonal (this form being selected on account of facility in packing) and consequently of a far more regular and milder nature than anything used in this country. As a natural consequence, the German powder makers acquired a skill in this particular manufacture, which even at the present moment we have scarcely equaled.

Good as P^2 was compared with anything which preceded it, something better was wanted, and after many experiments it was decided that the charges for the 80-ton and 100-ton guns should be made of German prismatic powder. The consequence of this change was a considerable increase of power combined with a considerable decrease in maximum pressure. The production of breech-loading guns of increased length has led to a further development of the principle of retarding the combustion of powder, by giving a low maximum, and at the same time a long-sustained, pressure. There is no doubt that in this direction lies the success of future powder-making. We may conclude this part of our subject by summarizing the necessary conditions for the manufacture of powder of this class:

1. Other things being equal, the harder the charcoal is burned the denser the finished powder, and the larger the grain the slower and milder the action of the explosive.

2. The moisture present exercises a considerable effect. Every effort should be made with each class of powder to ascertain the actual amount of moisture likely to be absorbed under ordinary conditions of service, and the powder when under manufacture should be stoved as nearly as possible to its normal amount. Such a course affords every guarantee that the powder on service will not vary under ordinary circumstances to any great degree from the samples from which the range tables have been made out; and, consequently, that the range scale will be fairly accurate, a point of the utmost importance, especially for naval and coast defense ordnance, where the effect of a few rounds (in general many rounds are not likely to be fired) may be of vital importance.

3. In order to insure uniformity in velocity, and consequently accurate shooting, it is absolutely necessary to employ a powder the separate grains of which are of absolutely uniform content and surface. This is self-evident. To obtain uniform combustion we must have a uniform amount of ignited surface.

4. The powder used for each calibre should be of the slowest burning nature compatible with the attainment of the required muzzle velocity. The strains both on gun and projectile are much reduced by carrying out this principle.

It is impossible within our present limits to lay down more defined rules. The foregoing conditions, however, cover the whole ground.

Next in importance to the class of powder employed comes the nature of the chamber in which it is fired. This part of our subject again naturally divides itself into two heads, (*a*) the form and proportion of the chamber, (*b*) the relation of its volume to that of the charge itself. There is little doubt that the best form of chamber theoretically would be a spherical one, care being taken to ignite the charge in the center. This form is, however, impossible from structural considerations, and in practice the shape is almost invariably cylindrical. Experience has proved that, if possible, the length should not exceed three and a half to four times the diameter. Should it do so, wave pressures of exceptional local violence and of destructive effect on the gun would probably be set up.

A powder chamber may be of the same or of larger diameter than the bore of the gun itself; roughly speaking, the former condition is characteristic of old, the latter of modern ordnance. The advantages of enlarging the powder chamber may briefly be stated—it renders possible the use of a short cartridge.

The first gun in which an enlarged powder chamber was definitely adopted in the English service was the 80-ton muzzle-loader, and it may be useful to recall the conditions which led to its general use about the period when the above gun was undergoing its first trials.

It was found that after a certain charge of the powder then used was exceeded, rammed up so as to fill nearly or completely the whole space in rear of the shot, the pressures developed were more than was consistent with absolute safety. More power, however, was wanted, that is, a larger charge. Researches on fired gunpowder had shown that the pressure caused by explosion depended to a very great extent on the volume of the chamber in which the charge was placed, or as it is technically expressed, on the gravimetric density. It was found by experiment that greater muzzle velocity and consequently energy was obtained when a large charge of less density was employed. It is evident that the only means of effecting this decrease of density was the increase of length and decrease of the diameter of the cartridge. This course is objectionable in many ways; it gives a very long, unwieldy cartridge, it is apt to set up severe local pressures, and causes a decrease of muzzle velocity, compared with what would be otherwise obtained, by reducing the travel of the shot or the distance during which the propelling power of powder gas is at work; practically as we elongate the cartridge we shorten the gun. Suppose now we enlarge the powder chamber of a muzzle-loading gun. It is thus possible to employ a cartridge limited only in its di-

ameter by facility of loading, that is to say, it may be very nearly as large as the bore, and its length consequently may be greatly reduced. In the enlarged powder chamber it is inclosed in a space much larger than is absolutely necessary to contain it, and its first developed pressures are, as explained above, much reduced, while the objectionable points in this system of air spacing, as it is called, are avoided. In breechloading guns the advantages conferred by an enlarged chamber are increased. The size of the bore does not limit the diameter of the cartridge. In fact, in very recent guns we believe that the system of air spacing has been abandoned, and the enlarged chamber used to hold an enormous charge of very slow burning powder; so slow burning that it does not require air spacing to soften its first effects. It is clear that the enlarged chamber in this instance acts as a well-shaped receptacle for a very large store of the propelling agent which gives off its power gradually, following up the shot in its travel to the muzzle with large volumes of newly-developed gas. It is evident in this case that an enlarged chamber is a direct gain in length to the gun, if not enlarged, in many cases the powder chambers would of necessity be double their present length. Even with very slow powder, such great length would probably give rise to severe wave pressures. To sum up then: powder chambers should be short, not more than 3½ to 4 diameters. Cartridges of quick-burning powder must be air spaced, that is with a given chamber they must not nearly fill it; with very slow-burning powder the chamber may be nearly or completely filled. We see then that with the latter a very much larger charge may be used.

The third principal condition regarding the action of fired powder is that of the ready moving away of the shot. It is evident that the heavier the latter may be in any given calibre, the more work is required to impart to it a given motion; after a certain limit has been exceeded, however, the increment of pressure caused by increase of weight of shot is very small, a point of considerable importance. It has even been found advantageous to cause resistance to motion when using some of the slow-burning powders of the present day, in order to get up a certain definite pressure in the powder chamber before the shot starts, and thus to avoid loss of muzzle velocity and power. When the resistance is diminished the powder is not so completely burnt, and a very serious loss of velocity ensues. A more scientific explanation is as follows: When the initial resistance to motion is small, with slow burning powders, the maximum pressure does not occur until the projectile has moved some distance, and during the interval comparatively little work has been done, while if some means of retention be adopted a definite pressure has to be reached before any movement whatever takes place. Incidental but important advantages accrue from furnishing the projectile with a strongly resisting rotating band, the usual artificial check. The chief of these is that the copper band on the shot (the system of rotation adopted by France, Germany, Russia, and probably by England also) is made of considerable greater breadth and bearing surface than is absolutely necessary to effect the rotation when the gun is new. When the latter has been fired for a large number of rounds, and the grooves become worn and rough, this margin or surplus of bearing surface comes into use and prevents stripping, and consequently imperfect rotation, such as would soon occur were a narrower and less resisting band employed.

Lastly, the action of fired gunpowder is affected by the position in which the flame from the firing tube strikes the cartridge. This is of special importance where quick burning powders or long powder chambers are used. When of a very slow nature and in masses not exceeding three and a half to four times the diameter, this condition may practically be neglected. Under other circumstances its importance is great. In the old guns of the English service, the tube struck the cartridge radially about midway in its length. A rear vent was inadmissible, as wave pressures were likely to occur from its use. In smaller calibres this was disregarded for a time, principally because with a rear vent the débris of the cartridge was more certainly expelled. The introduction of a material for cartridges which would not smoulder, has led, we believe, to a central or forward vent, as it is called, in nearly all such pieces in the English service, and a consequent gain in velocity and reduction of pressure has been the result. With heavy guns fired with suitable charges of slow burning powder, vents in the axis of the piece have been generally adopted throughout Europe.

A DEFUNCT RAILROAD.—A company of gentlemen met in Grand Rapids (Mich.) lately to consider the Kalamazoo and Lowell Railroad. A large proportion of the roadbed which was graded several years ago still remains, but in some places it has been obliterated. Where it runs diagonally through farming lands, in many cases the tillers of the soil have plowed through it.

BROADWAY UNDERGROUND RAILWAY—THE ARCADE PLAN TO COST $2,000,000 PER MILE.

The passage by the Assembly of the bill to modify the charter of the Broadway Underground Railway Company so as to permit the construction of its proposed road under the arcade instead of the tunnel plan has aroused much interest in the enterprise. The company's original intention was to build a two-track road underground along the line of Broadway from the Battery to Madison square, under Madison square to Madison avenue, and thence under the avenue to the Harlem River. Its charter also allows it to build a branch road under Broadway from Madison square to Eighty-third street, and thence to the Harlem. The officers of the company say that under any circumstances this road will be built, but the amendment of the charter so as to allow the adoption of the arcade plan of road will be better for the company and of greater benefit to the traveling public and to owners of property in Broadway.

The President of the company is Melville C. Smith, a wealthy owner of real estate. The trustees, who were recently elected, are Mr. Smith, William Windom, ex-Secretary of the Treasury; Jerome Fassler, Sr., Springfield, Ohio; H. C. Gardiner and Edward M. Clymer, President of the Buffalo, Bradford & Pittsburgh Railroad. The authorized capital stock of the company is $10,000,000. Only about $400,000 has been paid in for the purpose of raising the money necessary for surveys and engineering and other preliminary expenses.

The company's arcade plan, Mr. Smith adds, has been approved by such engineers as General George B. McClellan, William J. McAlpine, Egbert L. Viele, Julius W. Adams, Sylvanus H. Sweet, J. F. Quinby, John B. Jarvis, Silas Seymour, Charles H. Haswell, and Generals Wright and Newton, of the United States Corps of Engineers. The plan, in its general features, is as follows: Practically a basement street will be excavated under the entire length of the proposed route, about fifteen feet below the surface of the present sidewalks. The upper pavements will be supported on iron columns and girders, with arches between, and completed with a roadbed and pavement of the best construction. The underground way will be wide enough to provide for four railway tracks, with sidewalks on either hand for foot passengers. The company proposes to use the two central tracks for quick through trains, stopping at stations about a mile apart, and the two outside tracks for way travel, the trains running at slower rates of speed and making stoppages at every second or third cross street. At night, as the travel will be largely reduced in volume, it is intended to use two of the tracks for the transportation of freight. An area of space six feet in width, adjacent to the buildings, the plan contemplates, shall be kept open in order to supply air and light to the arcade tunnel. Stairways will lead down from the street to the arcade.

Of course the company will have to make provision for the removal of sewers, water-mains and gas and steam heating pipes along the line of its route. Its plan contemplates placing these in a conduit or vault, either under the middle tracks or below the underground sidewalks. The advantage of such a disposition of the network of pipes now beneath the surface is obvious, should it prove practicable. Ready access for examination or repair could be had to the pipes without the daily nuisance now undergone by citizens in the tearing up of the streets and the temporary blockade of travel. The company's friends recognize the difficulty they may meet from some private corporations, which may take advantage of its position to compel it to buy up their underground property. The company purposes to make the necessary changes without charge, and its friends are hopeful that some amicable arrangement can be made with all interests involved. In behalf of the company it is said that the present cellars of the Broadway stores can be converted into stores which will have as much air and light as any basement store now has. The arcade road, under such circumstances, would practically add another story for business purposes to the buildings along Broadway.

It is asserted that the construction of the road can be carried on without interruption of surface travel. The engineers who have approved the company's general plans describe the method of working as follows: "A series of parallel bridges are proposed to be used which will allow a vehicle to stand opposite each building and yet allow four other vehicles (two on each side of the street) to pass each other, similar bridges along the sidewalks allowing the foot passengers to pass freely, these bridges to be elevated four feet above the level of the street, with sloping approaches at each end, to be removed at midnight, panel by panel as the work progresses, side steps to each building giving access thereto. The surplus material taken out of the street and the new material required are all intended to be removed through the completed sub-way without in any case using the street therefor." The plan also provides for the placing of the new pipes and sewers in the sub-way without interrupting the supply of water and gas or the discharge of the sewage.

The officers of the company recognize the great expense that must attend the completion of their work. The cost of the road is put at $2,000,000 a mile, allowing for the expense of transferring the present system of pipes and sewage. This cost does not include the means of transportation. Whether these shall be provided by the use of an endless chain system or by supplying the motive power from compressed air, of the same pressure as steam, is a question not settled. The road when completed will be 11½ miles long, and the total cost is put at $25,000,000 at the outside. The greatest engineering difficulty to be overcome will be at Canal street, where the depression of the street would carry the excavation down to near water mark. The road may be carried over Canal street by a water-tight iron caisson. The company has filed a bond of $100,000 with the Controller of the city as a guarantee for the completion of the road to Forty-second street by 1886.—*New York Tribune.*

UNITED STATES LAKE SURVEY.*

The Lake Survey began its existence in 1841 with an appropriation from Congress of $15,000. Since that time annual appropriations have been made, the largest being $175,000. The work is under the War Department, and has been carried on by engineer officers with civil assistants. The purpose of the organization was to obtain a complete and accurate survey of the United States waters of the great lakes for the benefit of commerce.

The charts of the survey are all completed, and are now available over any route in the lake waters of the United States, extending from Duluth, Minn., to St. Regis, N. Y. Four thousand to five thousand charts are issued annually.

The normal plan for the survey of one of the great lakes was as follows:

First—The establishment of a primary triangulation, the average probable error of whose measured angles shall not exceed four-tenths of a second, the probable error of its bases not exceeding $\frac{1}{250000}$ part of their lengths.

Second—The determination from triangulation of secondary points along the shore line to be surveyed not more than ten or fifteen miles apart, these distances being much less when a secondary or a tertiary triangulation can be carried along shore.

Third—A detailed topographical and hydrographical survey along the shore, based upon these points, extending inland about three-fourths of a mile, and lakeward for half a mile, or to the four-fathom curve; scale of topographical sheet $\frac{1}{10000}$ or $\frac{1}{20000}$.

Fourth—A belt of off-shore topography done with a steamer, and extending from the four-fathom curve to eight or ten miles from land.

Fifth—Lines of steamer soundings across the lake.

Sixth—Precise determination of latitude, longitude and azimuths, at several primary stations.

Seventh—Reduction of field work and construction of maps.

The author proceeds to give a brief account of triangulation, bases, astronomical work, topography, and hydrography, levels of precision, meteorological data, comparison of standards, computations, and drafting. In measuring their principal bases they used an apparatus constructed by Repsold, of Germany. The tube of this apparatus is of thin cast-iron, canvas-covered, containing two bars, one steel, the other of zinc. The bars are placed side by side, and fixed at their centers, while their ends are permitted to slide by each other on expanding or contracting with the changes of temperature. Any change of length, owing to the unequal expansion of the metals is read with a filar micrometer, from the comparative scales engraved near the ends of the bars. These micrometers indicate changes to the $\frac{1}{1000}$ of a millimeter (about $\frac{1}{100000}$ of an inch). The length of the tube is four meters. Secondary bases were measured with rods of iron placed end to end on adjustable trestles; length of base, say two miles.

Tertiary bases were measured with a meter chain, twenty meters in length. Great care was taken in comparing standards. The Lake Survey observations show that metals have slight variations of length for the same temperature.

J. K. R.

CURTIS' STEAM TRAP.—The Freeman Manufacturing Company of North Adams, Mass., have recently put in 13 No. 2 Curtis' Steam Traps. This is their third order, given after the severest tests, and is certainly very creditable to the manufacturers, the Curtis' Regulator Co., of Boston.

*Abstract of a paper by John Eisenmann, Journal of the Asso. of Eng. Soc., August, 1882. Published in School of Mines Quarterly.

NATIONAL RAILWAY EXPOSITION NOTES.

Many car-load lots of entries for the National Railway Exposition have already been received. The crowds of workmen engaged in pushing forward the construction of the annexes and in preparing for and receiving exhibits make the exposition building and the adjacent grounds suggestive of a bee-hive at swarming time.

The most remarkable collection of locomotives, both ancient and modern, ever brought together will be exhibited at this exposition. Nearly all the leading locomotive builders of the country will show their latest and most perfect products. Among these will be the largest locomotive ever built, weighing over seventy tons, and fitly called the "Mastodon."

A large excursion of prominent citizens from Georgia, including the Governor and other state officials, will visit the Northwest in June, under the auspices of the Chicago, Rock Island, and Pacific Railroad Company. A special feature of the itinerary will be a visit of two or three days duration to the exposition.

One of the most remarkable of the more recent additions to the list of important railway appliances to be exhibited will be safety signal devices. Most of the electric and other signal systems will be shown in operation every day, some of the companies having secured several thousand feet of space each to exhibit the practical working of their system.

Mr. A. P. Swineford, Commissioner of Mineral Statistics for Michigan, has for several weeks been collecting and will forward to the railway exposition the most extensive and interesting collection of ores, especially of iron, ever seen in this country. Single specimens of these will weigh fully a ton, and the whole exhibit will make several car-loads. Very important collections of ores are also being made for this department in Alabama, Georgia, Tennessee, etc.

The electric features of the Railway Exposition will be among the most interesting of all, and will include displays of arc and incandescent lighting by nearly all the electric light companies in the United States. Several of these are preparing to exhibit on an extensive and almost extravagant scale. Among the novelties in this department will be that most remarkable recent discovery—the storage battery—by means of which electric energy can be accumulated in great quantities, stored for a considerable length of time, carried long distances, and then used to transmit power to motors, to supply electric light, and for various other purposes.

The most extravagantly beautiful effects will be produced by the introduction of colored electric lighting in and about the great fountain in the center of the exposition building, creating floods of gorgeous coloring. This single feature will insure the attendance of crowds every night during the Railway Exposition.

The English Commissioner, Mr. G. D. Peters, of London, is now on his way to the exposition in the steamship Alaska, and is bringing with him many interesting contributions.

RESISTANCE ON RAILWAY CURVES.

At the meeting of the Institution of Civil Engineers, held on the 24th inst, Mr. Brunlees, President, in the chair, the paper read was "Resistance on Railway Curves as an element of Danger," by Mr. John Mackenzie, Assoc. M. Inst. C. E.

It was stated by the author that when a six-wheeled engine with parallel axles was running round a curve, the tendency which the outer leading wheel flange had to mount the rail was evidently caused by its adhesion to the side or rounded corner of the rail, and that this adhesion was the result of a side pressure which, at low speeds, was principally caused by the resistance the treads of the wheels offered to the sliding motion that took place in going round the curve. He contended that this side pressure increased adhesion of the treads of the wheels to the rails, and that the adhesion of the flange itself to the rail also increased with the increased ratio of adhesion, so that the tendency of the flange to rise increased in something like the duplicate ratio of the fraction representing the co-efficient of adhesion. As the point of contact between the flange and the rail was in advance to the center of the axle, the motion of the flange at that point was downward, imparting a downward pressure to the rail, and an upward pressure to the wheel, so that when the flange adhered to the rail the wheel rose. Thus the pressure which would cause the flange to mount the rail was not that which, with the wheel at rest, would force it over the rail in opposition to friction as well as to gravitation; but the very much smaller pressure which, when the wheel was at rest and the tread raised slightly above the rail, would cause friction sufficent to prevent its falling into its place again. It had been found by actual experiment that the adhesion between wheels and wet rails with sand sometimes rose above 40 per cent. of the weight; and it might be found, by calculation, that with this proportion of adhesion, the side pressure on the flange of the outer leading wheel of many six-wheeled engines of not unusual proportions might, under certain circumstances, be so great as to cause the flange to adhere and mount the rail, and that, as regarded running off the rails, six-wheeled engines generally had a very narrow margin of safety.

MOVEMENT OF HEAVY CANNON ON RAILROADS.

A number of Pittsburgh manufacturers have warmly indorsed the proposition to establish a national cannon foundry in that city. Some controversy has been provoked by the statement of Lieutenant Mahan, an officer of the engineer corps, that the plan was impracticable, for the reason that, although Pittsburgh has practically limitless supplies of iron and coal, her transportation facilties would be found inadequate. The guns hereafter manufactured for men-of-war or harbor defense will, on an average, weigh about 100 tons, and he alleged that the movement of such heavy ordinance may be attended with difficulty, on account of such a load being to heavy for existing cars, tracks and bridges. On the other hand, Capt. Reilly, commandant of the arsenal at Pittsburgh, is inclined to think the project entirely feasible, and he adduces European precedents in support of his position. In 1879 a gun weighing upward of 110 tons was carried by rail from Turin to Spezzia, in Italy, a distance of about 300 miles, the car on which it was carried having previously, on a trial trip, carried iron plate weighing 120 tons for a distance of 120 miles. Herr Krupp's enormous guns are conveyed to their destination by railroad, and Captain Reilly observes that "the whole question, therefore, comes down to the relative position of railroads in Europe and America, and the advance of railroad enterprise in one country over the other. If our railroads are as good to-day as theirs, then the same feats can be accomplished here as well as in Italy and other foreign countries, where railroads have always been supposed to be behind American enterprise."

It is evident that the main point at issue is whether it will pay to transport such weighty ordinance. If it becomes a settled fact that heavy cannon may be profitably transported to the seaboard, cars, bridges, and tracks will soon be strengthened sufficiently to meet all the demands that may be made upon them.—*Railway World.*

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 205.)

DXXXII.—NATIONAL SOLDIERS' HOME, O.

The National Home for Disabled Volunteer Soldiers, near Dayton, Ohio, is under the control of a Board of Managers, elected by the United States Congress. It was founded in 1865, and is situated on high ground, 276 ft. above the Miami River and 4 miles west of the city. The first effort to procure a water supply was by sinking a large well to a depth of 100 ft, without successful result. For several years an insufficient supply was procured from springs and a small stream. A filter was built, 50 ft. square, the bottom composed of wooden slats, through which the water entered, passing up through 3 ft. of gravel. Owing to the exposure and trouble of cleaning it, this has been abandoned. The present works were laid in 1882 after plans of J. K. Rugg, chief engineer of the Home.

The supply is taken from artificial lakes in the Home, which are fed partly by springs and partly by the drainage of 2 square miles. The dam of the main lake is of clay, 35 ft. high and 40 ft. wide at top. In the heart of the dam is a clay puddle wall 24 ft. wide at bottom and 16 ft. at top.

The water is pumped by two horizontal compound condensing steam engines, steam cylinders 13½ and 23½ in. and pump plungers 10½ in. diameter, all of 30 in. stroke, built by the Cope & Maxwell Manufacturing Company. At present the water is pumped directly into the mains, with 75 lbs. pressure. A plate iron stand pipe 18 ft. in diameter and 148 ft. high is nearly completed. It is on ground 76 ft. above the lake. The pump main, of 14 in. diameter, is carried up inside the stand pipe to within 6 ft. of the top. Inside of this pipe a 3 in. wrought-iron pipe is carried, to be used as a steam pipe for preventing freezing in cold weather.

The force main from pump to stand pipe is of 10 in diameter. Distribution is by three miles of cast-iron pipe of 10 to 4 in. diameter, with 22 fire hydrants, 50 gates and 75 taps. Service pipes are of wrought iron.

Each building on the grounds is provided with a stand pipe with hose connections on each floor.

The population supplied consists of 4,000 old soldiers. There are no women or children, except in the officers' families.

The daily consumption varies from 300,000 gallons in winter to 500,000 gallons in summer. The works cost $37,500. The pipe-laying was done by inmates of the home, under the supervision of the Chief Engineer, J. K. Rugg.

DXXXIII.—JOLIETTE, QUE.

Joliette, Quebec, in Canada, is on level ground, on L'Assomption River. Settled in 1840, it was incorporated a village in 1843, and a town in 1868.

Water-works were built in 1873 by the town, after plans of P. Laforest, Jr., taking the supply from a stream fed by several lakes of very pure water.

The water is dammed, furnishing power to drive 7 in. rotary pumps built by Day & DeBlois. There is also a duplex steam pump of 7½ in. bore, built by Beauchemin fils, of Sorel, pumping directly into the mains with 50 lbs. ordinary and 90 to 100 lbs. fire pressure.

The water is conveyed to the pumps 9 miles in a 12-in. cast-iron pipe. Distribution is by 11 miles of cast-iron pipe of 8 to 3 in. diameter, with 1,000 taps. The number of fire hydrants is not given. The town pays $3,000 a year for hydrants.

The population is 3,600. The daily consumption is not known.

The works cost $40,000, which is the bonded debt at 6 per cent. interest.

The expenses in 1882 were $3,000, and the receipts $5,000.

The works are managed by the town council.

Pierre Laforest, Jr., is the Superintendent, and B. Vezina the Secretary and Treasurer.

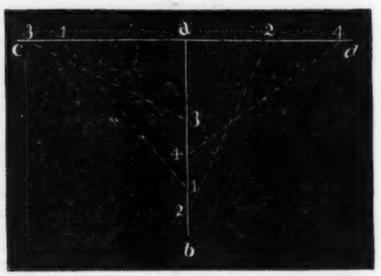
CORRESPONDENCE.

PLOTTING SURVEYS.

WARREN, Pa., April 25, 1883.

EDITOR ENGINEERING NEWS:

The following method of plotting surveys may be of interest, being simple, practicable, expeditious, and reduces mechanical errors to a minimum. No instruments are needed but a graduated scale, a ruler and a triangle. A table of natural sines and cosines will be required.



Draw anywhere on the plan to any convenient scale, a meridian line *a b*, ten units in length. Through *a* draw *c d* at right angles, making *c a* and *a d*, each ten units.

For each successive course of the survey, lay off the natural cosines of the bearing from *a* toward *b* (the decimal point being removed one place to the right) and the natural sines in like manner from *a* toward *c*, if the course is N. W. or S. E.; and toward *d* for N. E. and S. W. courses, marking the points 1 1, 2 2, etc. The lines need not be drawn.

These courses, 1 1, 2 2, etc., are then to be transferred by ruler and triangle to their proper places on the plot. Yours very truly

GEO. W. HOWELL.

DIVISION OF LANDS.

WARREN, Pa., May 5, 1883.

EDITOR ENGINEERING NEWS:

Referring to problem relative to division of lands in the NEWS of March 31, and to the alleged solution in the issue for April 21, page 185.

According to my calculations the proposed line from *a* to *f*, the middle point of *f g*, if produced straight to the line *i j*, already equates the parts cut off on each side within thirteen hundredths of an acre.

But, leaving out entirely the discussion of mere errors in calculation, the method suggested is wrong in principle and does not give the line required.

To obtain the true area of the triangle *f g h*

your correspondent uses similar triangles. The new division line thus obtained must be parallel to the first line *a f* produced, and cannot possibly form a straight line with the line drawn to *a*.

Again, running the course as proposed, from *a* through this new point on *f g* to the line *i j*, it will diverge more and more from *a f n*, and if your correspondent will take the trouble to calculate the areas cut off by this line, he will find that the triangle *f g h* is considerably too small.

If any reader of the NEWS has a method by ordinary mathematics for such cases, better than the "old and dangerous mode" by trial, it will be a public benefit if he will present it.

Of course this problem and all others of its class would be simple enough were it not for the complication in conditions as regards the area included between the lines *c b* and *d e*. Yours very truly,

GEO. W. HOWELL.

YE OLDE TIME SURVEYOR.

NORTH ADAMS, Mass., May 8.

EDITOR ENGINEERING NEWS:

DEAR SIR: In your issue of May 5, an article appears under the title of "Ye Olde Time Surveyor." The surveyor there alluded to was my great-great-great-grand father. I believe the compass upon whose *needle he depended* is or was a short time ago in the hands of some of his descendants of the present generation. I find, on reference to a book entitled, "Blake Family—A Genealogical History of William Blake of Dorchester and his Descendants," that the missing word in the fifth verse of the poem in the article of May 5 is "Charts." Yours very truly,

HARRY E. BLAKE, C. E.

EXPERIMENTS ON BRIDGE MATERIAL.

UNIVERSITY OF ILLINOIS, CHAMPAIGN, May 5, 1883.

EDITOR ENGINEERING NEWS:

It is well known that our information concerning the ultimate compressive resistance of wrought iron and steel is very unsatisfactory. Reputable authorities vary between 30,000 and 90,000 lbs per square inch as the compressive resistance of wrought iron; and the case is even more unsatisfactory for steel, with the possible exception of one or two grades. This is unfortunate on general principles, but especially so since it is confidently believed that rational column formulæ are in such a state of perfection that valuable results should be obtained therefrom, if we but had more definite information concerning the compressive resistance of wrought iron.

There are several reasons to account for the diverse results of the compressive strength of wrought iron. Chief among these is the difference in form of test specimens. This could easily be removed by detailing the form of test specimen as definitely and appropriately as is done for tensile strength.

If those who make experiments would give proper attention to reporting all the details concerning quality of the material and method of making the experiments, our knowledge of the strength of materials would be far more valuable.

I ask your indulgence for a few words upon another matter.

Some bridge specifications require that the elongation of iron tested to rupture shall not be less than a specified amount; and that the reduction of fracture area, shall not be less than a given minimum. The elongation is demanded to secure ductility. The reduction of area indicates the uniformity of ductility, *i., e.* the homogeneity of the material. For example, a large reduction of area would indicate a soft place at the point of fracture. On the other hand, a small reduction indicates a uniformity of structure. Experiments show that a large reduction is always accompanied by a low ultimate strength.

Consequently the thing to be desired is a small rather than a great reduction of fracture area. The specifications should state a maximum limit for the reduction instead of the minimum as now. Many specifications say nothing of the reduction of area, which is a neglect to consider an important element of the quality of material to be used.

Good bridge iron, tested in the usual way, will give a reduction about as follows:

Bar Iron	40 to 45 per cent.
Shape "	25 to 30 per cent.
Plate "	20 to 25 per cent.

Which quantities should be specified as the monimum permissible reduction of fracture area.

I. O. BAKER.

THE GOLDEN NORTHWEST.

The Passenger Department of the Chicago, Milwaukee & St. Paul Railway has issued a very gem of a book describing the many advantages offered by the "Golden Northwest," to the "tourist, the health-seeker, the man of affairs and the lover of the sublime and beautiful in nature." The book, a large octavo of about 90 pages, is most profusely and artistically illustrated in a style that would do no discredit to "Scribner" or "Harper," and higher praise we cannot give the wood engraving; they are from sketches made by a sympathetic artist's hand, and present in a most striking manner the little known beauties of the lake and mountain scenery of this far western land.

As this region is the one to be soon visited by the American Society of Civil Engineers, in attending the annual convention of 1883, this description of points of special note is timely.

PHILADELPHIA PUBLIC BUILDINGS.—John McArthur, Jr., of Philadelphia, was given the first premium, and he was appointed architect of the work December 27, 1869. For the information of the general reader it may be well to state the building alluded to is the new City Hall. The corner stone was laid July 4, 1874. Upward of $9,000,000 have already been expended upon it, and the lowest estimate of its final cost is set at $12,000,000, not including furniture. Other estimates place the final cost as high as $15,000,000, and it will not be finished for several years. The *Philadelphia Times* says: "The daily consumption of bricks is now 20,000, but 50,000 could be used if they could be had. From the beginning of the work to the close of last year there has been used in the building nearly 1,000,000 cubic feet of foundation stone, over 200,000 cubic feet of New England granite, over 600,000 cubic feet of Lee marble, over 100.000 cubic feet of buff and blue Ohio sandstone, 2,400 tons of iron floors and roofs, over 1,000 tons of cast iron fixtures, 405 tons of slate roof, and 57,215,608 bricks."

THE ARLBERG TUNNEL.—The total length of this tunnel will be 11,161 yards, or 6 miles and 601 yards. The method of excavation differs from that practiced in the making of the St. Gothard tunnel. Instead of piercing the upper part of the passage first, and working down, the Austrian engineers have preferred to begin at the base and work upward. The face of the rock is drilled by perforators actuated by compressed air, which is pumped into the tunnel by turbines stationed at its two extremities. When a sufficient number of holes have been drilled they are charged with dynamite and exploded. After the blast the *débris* is removed by trucks, which follow closely on the track of the perforators, and a few minutes later the drilling is going on as rapidly as before. The drift thus made is 2.75 meters wide and 2.50 meters high. While one drift is being driven below, another, to which access is gained by vertical shafts, is being driven above. This work has necessarily to be done by hand, and the rubbish is shunted through openings, made for the purpose, into an inferior gallery. Until very lately the ventilation had given rise to no difficulty, and the heat has rarely exceeded 14 deg. Centigrade (58 deg. Fahrenheit). The contractors have undertaken to make an average advance of 6.60 meters a day. For every day they exceed the given time they will be mulcted in a penalty of £68; for every day gained they will receive a premium of £68. So far the contractors have kept well up to time. On not a few occasions the agreed rate of advance has been more than doubled. From January, 1881, when the work began, to September 30, 1882, the length pierced on the east side was 2,976 meters; on the west, 2,643; together, 5,619; equal to 8.80 meters daily, figures which are highly significant of the progress made of late years in the method of boring great tunnels. In the month of February last the rate of advance per day was 4.68 meters on the east side, 4.74 on the west side, and but for the scarcity of water, owing to the freezing of the sources of supply, a still better average would have been made. On the west side there is now a stretch of 3,070 meters practicable for locomotion, while on the east side the completed stretch is only 1,430 meters. Up to the end of February the quantity of earth and rock removed amounted to 429.082 cubic meters, and the walling to that date executed measured 121.511 cubic meters. The tunnel is expected to be completed and the line ready for opening by the autumn of 1884.

THE TUNNEL UNDER THE MERSEY.—The railway tunnel under the Mersey, from Liverpool to Birkenhead, is now being rapidly pushed on towards completion, the works, both on the Cheshire and on the Lancashire sides, being well under the bed of the river, where they are being carried through a stratum of new red sandstone, of a very firm description, well adapted for tunneling, and yielding but little water. The total length of the tunnel will be about three miles, and the length of the subaqueous portion three-quarters of a mile; and the work, as a whole, will not only connect the two towns of Liverpool and Birkenhead by local trains, so as to do away with the inconveniences of the ferry-boats now in use, but it will also permit the passage of through trains belonging to the several railroad companies of the district, all of which will be able to obtain running powers over the underground line. Seven hundred men are now constantly employed on the works; and it is expected that it will be possible to walk through the drainage headings, from one side to the other, in the course of the present year, and that trains will be running through the main tunnel in about 18 months or two years. The excavations have been carried on, until lately, by pick and shovel; but these are now superseded by the Beaumont boring machine, driven by compressed air, a contrivance which has been in use on the French side of the Channel Tunnel. This machine has been found in practice to accomplish an advance of a quarter of an inch per minute, or ten yards in 24 hours; and at this rate the work is, for the future, expected to be carried on toward its completion.

UNDERGROUND TELEGRAPH LINES.—It becomes every-day more and more certain that the nuisance of telegraph and electric light poles and wires is doomed. Public opinion must ultimately get the best of venal and mercenary legislation, and when that day comes Western Union will necessarily be the heaviest sufferer. Jay Gould is unquestionably a man of great genius. He is probably the smartest man of the age. But he made a great mistake when he loaded himself with the heavy burden of a national system of communication which is constantly threatened by new scientific discoveries and new requirements of public convenience. His thorough knowledge of the country and its resources, his experience in railroad management, his mastership of the corporation laws, and his unscrupulous boldness in handling men and things make him an absolute master of any railroad scheme he chooses to enter upon. All the Vanderbilts, the Villards, the Huntingtons, and the Dillons are mere pigmies when compared with him. But telegraphy is constantly at the mercy of new discoveries, and a half-starved electrician or chemist might any day ruin Gould's brightest hopes and his finest combinations. The recent visit of Mr. John Pender's son to this country disclosed the fact that the main reason why the old "Cable King" did not go into the directorship of the Western Union, and did not do anything toward listing the stock of that company on the London Stock Exchange, was not so much the disagreement with Mr. Gould in regard to the cable monopolization, but the fact that he had seen a piece of the compound wire of the Postal telegraph system. and had been initiated into the manner of its working. After having thoroughly examined both, he declared that we were probably on the eve of a revolution in telegraphy, and shut right down on the Western Union. The present visit of Dr. Green to England is therefore not at all likely to improve the chances of the listing of the stock on the London Exchange. The lawsuits and dividend injunctions alone would be sufficient to deter the British investors, not to speak of the unfavorable influence of Mr. Pender's views. In a few days the underground laying of the Postal wires will be completed to Chicago, and the working of the new system will thus be tested publicly. The wire factory at Ansonia, Conn., is said to be running to its full capacity to secure a speedy extension of the new company's lines to all the large cities of the Union. Wall street has credited Mr. Gould with possessing or controlling $60,000,000 worth of the Western Union stock, but it appears from the report of last Friday's meeting of the Western Union stockholders that he voted for the lease of the Mutual Union only upon 270,000 shares. He is, therefore, not so badly off after all, for he will have ample time to sell some more stock before the Postal or any other improved system puts the Western Union into the background. The progress of science may be preparing a little Moscow for the Wall street Napoleon, but there is no danger of his being dragged into a Waterloo.—*N. Y. Sun.*

CHINESE VS. WHITE LABOR.—White mechanics and laborers are arriving in large numbers in Victoria, British Columbia. Railway contractors declare that Chinese labor is unsatisfactory and more expensive than white. A contractor for the Canadian Pacific has engaged 3,000 whites.

ENGINEERING NEWS
AND
AMERICAN CONTRACT JOURNAL.

Tribune Building, New York City.

The Engineering News Publishing Company, Proprietor.

Published Every Saturday.

CONDUCTED BY

GEO. H. FROST and D. McN. STAUFFER.

TERMS OF SUBSCRIPTION:

$4.00.....PER YEAR TO U. S. AND CANADA.
$5.00 ..... " " " FOREIGN COUNTRIES.

Make all drafts and cheques payable to ENGINEERING NEWS PUBLISHING Co. Postal Money Orders, for convenience, may be made payable to GEO. H. FROST.

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NOTICES OF MEETINGS.

AMERICAN WATER-WORKS ASSOCIATION.—Meet at Buffalo, N. Y., May 15, 16, 17 Headquarters, Genesee House. Excursion to Niagara Falls.

EAST RIVER BRIDGE.—Will be opened 24th inst.

A meeting of the Ohio Institute of Mining Engineers will be held at Youngstown, Ohio, on Wednesday, May 9, 1883, with headquarters at the Tod House.

The meeting is public, and all are invited. A full attendance of members is expected. Representatives of the leading Mining and Civil Engineering Journals will meet with us.

The exercises will consist in the reading of papers. Discussion of the following topics:

"Signals in Mines," "Lighting of Mines," "Fees and Salaries," "Mining Machinery," "Old and New Metheds of Working Coal," "Mining Engineering and Surveying," "New Legislations," "New Litigation," "Surveying Instruments," "Oils," "Lamps," How to Keep Survey Points," "Drill Holes," "What is Minable Coal," "Horsebacks," etc., etc.

Report of Committee on Constitution. Reports of Officers. Inspection of Mines near Youngstown.

A. ROY, President.

R. S. PAUL, Secretary.

AMERICAN INSTITUTE OF MINING ENGINEERS,
SECRETARY'S OFFICE.

The next meeting of the Institute will be held at Roanoke, Virginia, during the first week in June. A detailed programme of sessions and excursions will be issued early next month. Members are requested to send to the Secretary as soon as possible, the titles of the papers they intend to present at this meeting.

EASTON, Pa., April 2, 1883. T. M. DROWN, Secretary.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The annual Convention of this year will be held at St. Paul and Minneapolis, Minn., beginning June 19, 1883. Full arrangements will soon be announced.

It is also proposed to make special provision for a visit to the Exposition of Railway Appliances, at Chicago, before proceeding to St. Paul and Minneapolis.

JOHN BOGART, Secretary.

APRIL 5, 1883.

THE engineering profession is essentially cosmopolitan—composed, as it usually is, of gentlemen who have "*seen* the world" and much surveyed. The Bohemian Engineer and Architect Society has decided in confining its discourses to pure Czech, and declared it the language of the Union. The vote was 90 to 35. The German organ of the Union will be replaced by one in Bohemian, and the probability is that the split will not inure to the prosperity of the "*Verein*."

THE PATENT OFFICE NEWS.—This is probably the latest born of weekly publications, and in appearance does credit to the authors of its being. It is devoted exclusively to patent interests, promising to give each week a resumé of patent office proceedings, including the decisions of the Secretary of the Interior, Committee of Patents, Examiners, etc., to present a complete list of patents as issued, and to keep its readers generally posted upon all that pertains to patents, American and foreign.

We believe it will be welcomed by the inventor, and in all manufacturing communities, and we wish it success. The office of publication is in Washington, D. C. The price is $2.50 per year.

THE U. S. PATENT OFFICE.

As an index of the inventive talent of the American people, the growth of our industries, and the generally healthy tone pervading all manufactures, the vastly increasing business of the U. S. Patent Office is worth investigating. If it did not pay to invent new machines or processes, that institution would lie idle; per contra, it must pay, if we can judge from the business actually done.

In 1837, 435 patents only were issued; in 1882 this number had swelled to 18,135, or, including reissues and designs, to 19,267. The total number issued between the years named is 269,820. Last year 31,522 applications were filed, and, from present indications, the records for 1883 will show fully 40,000.

The case with which the application can be made and the low fees charged in the U. S. Patent Office have, of course, much to do with the vast number of claims that annually come to Washington; and these conditions encourage every country lad who has an idea, be it ever so nonsensical, to attempt to patent it. In England $1,000 is the cost from first to last for a patent for 14 years that some one else *may* have patented before you; in the United States, after a rigid examination into the existence of prior claims, $25 secures sole proprietorship for 17 years. The American inventor is not slow in making use of his advantages, and the world is being rapidly flooded with the offspring of his busy brain and practical common sense.

THE FORTH BRIDGE.

One thousand men are engaged on the preliminary preparations for this great undertaking; buildings are being demolished, and the foundation work is being prepared for.

The two deep water spans will be 1,700 ft. each, between centers of cylinder piers. Each pier above water will be made up of four cylinders, united transversely and longitudinally. In the line of the bridge the cylinder piers are 150 ft. apart, except in the center pier, where they are 270 ft. between centers. The 1,700 ft. span is made up of two cantilevers approaching within 500 ft. of each other at center of span, which latter space is spanned by an ordinary girder. The elevation of the bridge at highest point of roadway is 150 ft. above high water. The main compression members in the cantilevers are steel tubes 12 ft. in diameter at base. The strain is limited to 6½ tons per square inch of sectional area of metal. At the piers the tubes spread apart 112 ft. to give lateral resistance, approaching to within 30 ft. of each other at the center of bridge, to accommodate a double line of rails.

Thirty pounds per square foot was originally allowed for wind pressure, with a "safety factor" of four. With this pressure the lateral deflection at center of span would be six inches; vertical deflection under a 400 ton train is to be one inch. Since the adoption of the 30 lb. basis the Board of Trade ordered that the maximum allowance for wind pressure should be 56 lbs. per square foot, but this is very generally considered unnecessarily excessive, and should be used only in very exceptional cases of exposure.

THE CHANNEL TUNNEL.

The joint committee of the houses of Lords and Commons held their first meeting week before last to hear evidence regarding the expediency of constructing a tunnel under the English Channel.

The first witness was Sir E. Watkin, one of the promoters of the scheme; he testified that the tunnel would be equal to the conveyance of 13 to 14 million passengers annually; 250 trains each way per day was the maximum traffic intended, though the London Metropolitan Railway ran 550 trains safely in the same time; 45 miles per hour was the proposed speed. With the experience they have already had, he thought the tunnel could be built for $15,000,000, and while the government should retain the right to assume control, he stated that it could be built by private enterprise for half the money the government would expend in the same work. Sir E. Watkin contended that the tunnel was a commercial necessity to protect and promote English trade, and that the English should not be content to go on living in their "fool's paradise," dependent for everything upon the sea. The company would build a fort to protect the tunnel, and there seemed to be no reason to apprehend any political complications between England and France that could not easily be provided for. The committee of management could be composed of three elements—viz.: the commercial proprietors of England, the commercial proprietors of France, and the representatives of the governments; international bodies of this kind already exist at both the Mt. Cenis and the St. Gothard tunnels.

Sir F. Bramwell, the consulting engineer of the Channel Tunnel Co., was next called; he simply approved of the remarks of Sir E. Watkin, and went on to say that judging from the experience resulting from the increase of facilities of communication at other points, he had no doubt but that the channel tunnel would also much promote traffic. In answer to questions put, he said his intention was to construct at the English end a station and custom-house sufficiently strong to resist any number of armed men; at each end of the custom house would be a strong grating, weighing 100 tons, in sliding grooves worked by hydraulic power, the grating to be so strong that nothing short of a 40 ton gun could injure it. The machinery was to be interlocking so that when a train entered through one gate the other would close. Besides these gates there would be a system of sluices able at any time to fill the tunnel in twenty minutes; he admitted that dynamite might damage the gates, but thought no party in the tunnel would care to use the quantity required, as they would assuredly destroy themselves as well.

RAILWAY DRAINAGE.

Perhaps there is nothing of equal importance that engineers are so liable to neglect as to provide for thorough drainage of road-beds and rights of way. Not that they do not recognize the importance of thorough drainage, but they frequently fail in judgment of the requirements of certain localities in that respect. And again, the engineer in charge of construction, having no interest in the road other than to see the contractors through, rarely goes farther in this direction than is actually necessary, leaving the finishing up for the company's engineer when they have accepted the road. It frequently happens that a road is located and completed in a few months which may be an exceptionally dry season, and the engineer deceived as to the amount of water that must be got rid of in wet or extraordinary seasons. In low, swampy grounds, pains are not always taken to keep the water as far from the road-bed as the right of way will allow and not interfere with fences. Ditches and borrow pits are frequently so near the grade as to keep the road-bed constantly soaked, and it is impossible to keep a good surface on the track with any amount of ballast. A little attention to this by those in charge of construction will save a great deal of trouble and expense in repairs. It is also noticeable that in many instances of roads being located on sloping ground, water is carried long distances on the upper side before being carried across the track. It is better to get the water into the lower ditch as soon as possible, after it reaches the right of way. Of course it is not pleasant to build culverts at short intervals, and they add somewhat to cost of construction, but culverts "pay in the end." This has reference more especially to providing culverts to prevent *soakage*. Small streams and natural water causes are usually provided for, although the passages are frequently too small and cause trouble in times of high water. In hilly or mountainous localities too much care cannot be exercised in determining the dimensions of water passages. It has frequently happened that a little more room at a water passage would have saved money, lives, and much property, and it would be difficult to err on the side of too much

water space in any locality. In many of the cuttings on hillsides and mountain-slopes much trouble is caused by water coming down the slopes into the cuts, carrying earth and boulders into the ditches or on the rails. Much of this trouble may be prevented by cutting ditches on the slopes above the slopes of the cuts and carrying the water into channels away from the road-bed, as may readily be done in most of such localities. Very deep cuts are usually narrow at the bottom, and mud and stones are very liable to find their way into the ditches at the ends of the ties, or are precipitated in large quantities on the track, with serious results. To keep ditches clear in these cuts requires the constant care and labor of the trackmen, and the mud train must be frequently brought into requisition. Proper attention to drainage would do away with much of this labor, trouble and expense, and prevent many serious accidents, besides the saving in wear and tear of track and rolling stock incident to track being in bad condition. In many places streams run for some distance near the foot of embankments with no protection, and high water is likely to cause trouble. Piling, rubble, rip-rap, or a judicious use of old ties in such places, is too frequently neglected or overlooked, as is shown by the numerous accidents from "washouts." Masonry foundations are too often left without sufficient protection from the action of water, and trestles are frequently damaged or destroyed by high water and drift-wood. Trestles should be protected by booms or piling, or in some effective manner. Cattle guards and road crossings give much trouble by holding water, and these places do not receive the attention they deserve in the way of drainage. The numerous accidents from failures of culverts and trestles, and wash of embankments and surface of road-beds may be regarded as evidence of general neglect, oversight or misjudgment of the importance of thorough work in drainage. It is not expected that ordinary or even extraordinary care in this respect will prevent injury to roads in all cases of high water or floods of unusual occurrence, but the melting snows and ordinary rains are frequently destructive, and this is to urge more strict attention to the matter as a means of saving life and property in what may be termed "every-day weather," or storms of average severity. Nor can it be expected that engineers of construction can at all times leave the work with a *completed* system of drainage, for reasons too well known to need mention here; but they can improve on the prevailing custom of leaving as much of this work as possible for those who come after them. When work is left to be done at some future time it is liable to be postponed indefinitely, or perhaps never done, or at least until the neglect has caused damage. In taking charge of new roads, engineers of way can usually find drainage a profitable study in making good the shortcomings of those who have gone before, and it should be attended to at once.

THE NEW TAY BRIDGE.

The construction of the new Tay bridge has actually commenced. The design adopted is that of the Messrs. Barlow, Civil Engineers. The new bridge is located about 90 ft. up-river of the ruined structure, no part of which is to be utilized. There will be 86 piers, in pairs, the spans varying from 66 ft. to 245 ft.; in the middle of the river the headway is 77 ft. above high tide, 11 ft. lower than the old bridge. The piers, above water, of the present bridge will be wrought iron, and the bridge will carry a double track.

Three piers on the north side of the river have already been built; they are of brick with granite coping, each 33 by 7 ft., and the spans, 66 ft.; there will be four brick piers of the same dimensions, practically, on the south side; all the foundations of the remaining piers will be of brick work within iron cylinders, cast iron being used in the shallow water, and wrought iron in the deeper portions. The cast-iron cylinders, one of which is sunk, are 9 ft. in diameter, cast in sections 6 ft. long, and the metal 1⅛ inches thick; the flanges are 6 in. wide with 1 in. bolts. The bottom section is 10 ft. in diameter and 2 in. in thickness; the second section from the bottom tapers from 10 to 9 ft. Two completed cylinders will form a pier, located 35 ft. apart from center to center; they will be carried 8 ft. above high water. There will be 23 cast-iron piers. Iron girders 2 ft. deep will unite the two cylinders, and above this girder the pier will be continued in blue Staffordshire brick for a height of 7 ft.; and on this a wrought iron superstructure will extend to the bridge trusses. The deep water piers will be founded on wrought iron cylinders from 15 to 23 ft. in diameter, located in pairs, and completed as described for the cast-iron cylinders.

The gradient of the bridge averages 1 in 114 ft. The girders will be of the ordinary lattice description, and of the same depth as those on the old bridge; the floor will be wholly of iron, the bridge being a deck bridge, except immediately over the channel. We quote the following from the *Scotsman:*

"The method employed for sinking the cylinders in the bed of the river is much superior to that which was in vogue when the old bridge was erected, and renders the workmen entirely independent of wind and tide. Except in the event of anything going wrong, no divers are required. In this important and difficult part of the undertaking a large iron pontoon, weighing about 100 tons, is used. Piercing at each corner the huge tank of which it is composed are four heavy cylindrical "legs," upon which it may be said the pontoon is hung—part of the "legs" being under water and part in the air. The pontoon is floated over the exact spot where the piers are to be sunk, and the legs having been let go pierce the bed of the river, and hold the pontoon fast. Then the pontoon, by means of hydraulic jacks, is lifted clear of the water—three, four or five feet, if necessary—and worked from this elevated platform, no weather can disturb the sinking operations. Cut in the pontoon are two apertures, the exact distance apart that the pair of cylinders should be when in position, and upon it are a pulsometer, steam crane, and apparatus for working a patent excavator. The cylinders are floated out to the pontoon in sections, firmly bolted together upon it, and lowered to the bed of the river through the apertures—there being mechanical "guides" to keep them upright in their descent. The patent excavator is then set to work to dig out the soil inclosed by the cylinder; and as that is cleared away the massive iron frame slowly sinks into the bed of the river. In sinking the cylinders at the north side a bed of tough red till or boulder clay was encountered, and upon that the pier in question rests. The "digger" is capable of lifting about a square yard of material at a time; but the progress it makes is, of course, entirely dependent on the nature of the strata through which the cylinder has to pass. On getting into the clay the cylinder becomes watertight and the water in it is pumped out. Workmen can then descend and proceed to make the pier solid by means of brick and concrete. In so doing there is, first of all, a layer of concrete, 15 ft. thick, spread on the bottom, and upon this a ring of brickwork is built up to the top of the cylinder—the bricks "butt" close to the iron. The central cavity is afterward filled with concrete, and the pier thus becomes a structure of great solidity. A larger pontoon, constructed on the same principle, is to be employed at the south side of the river, where it will probably make its appearance in the course of next month.

"For the floating out of the cylinders a wooden jetty on which is a steam crane has been built at the end of the Esplanade, and within the yard previously referred to are two powerful traveling steam cranes, concrete mixers and appliances in the shape of tipping bogies and other convenient forms of wagon for conveying material to the bridge. On the south side there is also a jetty communicating with the yard there by means of an inclined railway, and there are also all the necessary machinery for the lifting and transit of stone and iron. In reference to the discussions which took place at the Board of Trade inquiry as to the tendency of concrete deposited in iron cylinders to expand and contract, it may be mentioned that all the Portland cement used in these works will, as a precautionary measure, be exposed in ten-ton lots to the air in large sheds for a month. In that way it will be thoroughly cooled before being mixed. In the yard on the north side are about 100 sections of cylinders of different sizes, the delivery from Glasgow being at the rate of four or five a week, so that during the summer there is no likelihood of the workmen at the bridge getting beyond the manufacturing capacity of the foundry.

"The officials responsible for the construction of the bridge are Mr. Kelsey, M. I. C. E., the resident engineer for Messrs. Barlow, and Mr. W. Inglis, C. E., the resident engineer for the contractors. The bridge, which is to cost about three-quarters of a million sterling, is expected to be finished about the end of 1885."

THE RAMAPO WATER SUPPLY.

A recent publication advocating the introduction of water to the City of New York from the Ramapo district, Rockland County, calls for some comment so far as to question the availibility of the source to supply the amount named for each and every day of every year. In other words, the projectors of the scheme appear to have based their estimate of water supply upon averages of rainfall, instead of minimum rainfalls; while it is well known that many failures, if not absolute suffering, has ere now grown out of a reliance upon average rainfalls for estimating city supply by gravitation. So well known is this fact, that it is needless to cite examples in proof.

The Ramapo River, rising in Rockland County, N. Y., flows into New Jersey, with a drainage area in the former State of 108 square miles, and unites near Pompton in the latter State with two other streams, forming the Pompton River. The State authorities of New Jersey have looked to raising the dam on this river and furnishing thereby storage for the surplus waters of the entire Ramapo water-shed of 148 square miles.

The project to furnish 50 million gallons of water daily to the City of New York, to be increased to triple this amount, from 85 square miles of the upper Ramapo shed in the State of New York, it is estimated will abstract from the water power now enjoyed in prospect within the State of New Jersey above Paterson no less than 5,000 horse-powers. The rights of riparian owners through whose property living streams flow is well understood. No permanent diversion of water, so as to deprive owners in the stream lower down of their natural right to the water, can be made, unless by compensating them for its value. How far the State, interested in the development of her industrial resources, can be made to appear as a riparian owner, and so contest the diversion of an entire river, the natural flow of which was through her territory, is not so clearly determined But the steps taken by the State of New Jersey in the appointment of a Board having the conservency of the water-courses of the State under their jurisdiction, points without doubt to some litigation in the future, attended with possible uncertainties and delays being likely to arise before a question so vital to State interests can be considered as settled.

Resuming the engineering aspect of the question under consideration as the one which more particularly concerns us, we quote as follows from an article in the New York *Times*, of April 15: The Board of Underwriters of the City of New York asked a committee of merchants, of which Mr. C. S. Smith was chairman, to examine and report upon this Ramapo scheme. In a long interview with the engineer of the scheme, the latter is reported to have stated "that more water could thereby be made available for supplying New York than could be had from the Croton district." He must have been misquoted in this, for he well knows that the Croton shed of 360 square miles, with its capabilities for storage reservoirs, and a yearly rainfall in excess of that of New Jersey, could be made to supply at least *fourfold* as much water as from the Ramapo district of eighty-five square miles in Rockland County. The accuracy also of the statement, "that between now and January, 1885, he could lay two lines of iron pipes which would bring 50,000,000 gallons daily to the Central Park" may be questioned. In view of the likelihood of long litigation with the authorities or individuals resident in New Jersey who are to be dispossessed of their rights to the natural flow of the river, this is, to say the least, independently of any physical obstacles to the early completion of the work, disregardful of possible contingencies; and as *time* is the all-important factor in estimating the value of *this* water supply, we

would suggest that an engineer might well consider whether this project of his is really either the cheapest or the most speedy and certain method of increasing the *pressure* of water for fire purposes in the City of New York, for he goes on to say "that this project is the only method by which a head of 300 feet can be had at the Central Park, which head is of more account in the consideration of the water supply for fires," than is volume of water, and the chairman states that "one day's supply from the Ramapo, or $\frac{1}{365}$ of the annual delivery, will answer the demand for water for fires," and that for such purpose, "it is increased *pressure* and not increased volume of water which is needed." This is probably the fact, if it be intended, as is stated, to draw the water for the extinguishment of fires direct from the pipes and dispensing with the use of portable fire-engines; a scheme, by the way, which has frequently been suggested and in part carried out, but never with complete success, and is impracticable in a city like New York, unless the entire distribution be brought permanently (and not at intervals as needed by patented devices) under the increased head required for fires. The effect of subjecting all the city pipes to a constant pressure of 300 feet would add very largely to the expense and loss by rupture and leakage. Whoever has drawn water from an ordinary faucet, under a head of 300 feet, will understand without further comment the effect of such a scheme in a city like New York. If it be desired to have a fire main with branches in the lower part of the city, from which water can be led by hose for fires, in the method proposed by this committee of the Board of Underwriters, permit us to suggest, that two lines of 3 ft. 8 in. pipe be laid from the reservoir at Boyd's Corners in Putnam County, a reservoir holding near 4,000 millions of gallons, and already built and in operation, with its water surface elevated 600 ft. above tide, and distant say 40 miles from the city line. These pipes would deliver 50 million gallons daily at the city line under a head of 300 ft. When the entire pressure is needed in the lower part of the city, the operation of an ordinary gate will transfer this pressure to the fire main. Surely this is a simple method, more certain and efficient when reached, than to gather the water from a score or more of reservoirs in Rockland County with all their automatic contrivances under private management, and bring it in four lines of pipes under the Hudson River, and sell it to the city.

In the report of the Engineer under consideration, he wisely states "that what has been will probably be repeated, and the available quantity of water from any district, if sufficient storage is provided, will be arrived at by an intelligent and careful person with accuracy from a knowlege of what has previously occurred." And then proceeds, losing sight of the very premises he has so carefully established, to *estimate* for the Ramapo district, one-fourth more water per square mile, than can be obtained on the upper Croton water-shed. We agree with this Engineer in some things, notably, that a single fact is better than volumes of hypothesis, but we do not consider that anything which he has thus far offered by any means sustains his estimate of the amount of water to be had from the Ramapo for every day in the year. There is not a particle of evidence shown that the Ramapo shed is more productive of water than is the upper Croton shed, and yet he estimates the flow from 40 square miles of the former at such an amount as, if extended to the Croton shed, would show a daily delivery of 450,000,000 gallons in the dryest years from the latter. And to sustain his estimate of the yield of the Ramapo, much plausible hypothesis is resorted to, which is misleading in its application to the water supply of a great city. If the Ramapo scheme aimed but to provide a limited supply of water under a high head for special purposes, it might not prove so very objectionable; but the advocates of the scheme look beyond this, and contemplate the final disposal of their works, to be regarded as a valuable auxiliary to the permanent supply of the city.

Volumes have been written upon the subject of meteorology, but as yet sufficient facts have not been gathered upon which to rear a scientific structure properly so called, and the branch of the subject which treats of rainfall, evaporation and absorption, is still too obscure to enable us to do more than to make at times guesses, which the facts subsequently noted may prove to be more or less approximately correct, but disproved very possibly on the next occasion as wide of the truth, and without indicating any clue to the cause of the discrepancy.

In the matter of rainfall, it appears to be a well-attested fact that the higher the measuring gauge is set above the surface of the ground the less rain will be indicated. This peculiarity is shown even in the case of such precipitous cliffs as the Palisades, where less rainfall is indicated at the top than at the bottom. This at present recognized fact remains as yet unexplained, while it is generally conceded that the higher one ascends on mountain sides (within certain limits) the greater is the rainfall; and in view of the mode in which rain-clouds gather their moisture, whether from ocean currents or from re-evaporation from the earth's surface, the explanation has been supposed to be obvious; and there was an old English rule, now somewhat obsolete, that for every 100 feet of increased mountain elevation there was an increase of precipitation of rain of 3 per cent, but long-continued and reliable information, under varying conditions, in all latitudes, may be cited in support of either side of this question, and so conflicting are the records in these cases that the principle and only fact which remains unquestioned, is simply that as yet we know too little of the processes of nature by which precipitation of rain is effected or modified by evaporation or other phenomena. To enable us to determine *a priori* what will obtain in a given case, even after continued observations in a locality have been carried on for years pointing in one direction, anticipations may be set at nought, by a meteorological condition, so anomalous that in the case of providing for a city supply of water ordinary prudence calls for a complete disregard of *averages* of years, and the only safe basis for calculation becomes the *minimum* observed rainfall and flow; or, in the event of large storage facilities being at hand, the *two* or *three* consecutive years of least flow in a series of years, the larger the series the better.

Space will not permit at present the citing of authorities in full, in support of the above statement, but referring to the principles established by the engineer of the Ramapo project "that what has once occurred may in the course of nature be again expected," we shall introduce a few facts which scarcely admit of more than a single interpretation.

On page 6 we note as follows: "The rain gauges on and near this district (upper Ramapo) and the observed flow of the mountain brooks in the main river, as might be expected from these circumstances, show a larger amount of rainfall and a greater ratio of available water therefrom than is usually attained from equal areas of water-shed."

We are neither shown nor referred to any record of actual observation for comparison of either rainfall or flow on the Ramapo, but a series of observations at Boyd's Corners, on the Croton shed, for a limited term of years, is given, which were published by the observers in the proceedings of the A. S. C. Eng., May, 1874, but not, as is erroneously stated, published by the Croton Department, and was for five years extended by other observations—in all to a total of eight years, and comparing it with the Greenwood Lake, in New Jersey (west of the Ramapo), the latter for *two* years only exceeding the Boyd's Corners rainfall by 15 per cent. per annum, and Greenwood Lake being 500 feet below the mean Ramapo level, the inference is drawn—for it is nothing more—"that the rainfall on the Ramapo shed, which is 1,000 ft. above tide, *will be at least* 20 *per cent. greater than that of the Croton basin.*"

This engineer clearly confounds, as shown by his reference to Boyd's Corners in the Croton, absolute height with the relative height where, on a given mountain slope, in the *same* valley, exposed to the *same* winds, an increase of rainfall may be *expected*. According to his view, every location of the height above tide of over 560 ft. must be expected to show a greater rainfall than Boyd's Corners, whereas this is not the fact. By his own showing, Lake Hopatcong is 914 ft. above tide, and he admits that the rainfall for 21 years was 6 per cent. less than at Boyd's Corners, but offers as an explanation "that the high range of country to the south of Hopatcong cuts off the vapory winds from the ocean, and lessens the rainfall." Now we deny that any such high lands exist south, southeast or east of Hopatcong (in the direction of the ocean winds), but on the contrary, as will be seen by the map of Prof. Cook, State Geologist of New Jersey 1876, the elevations in these directions have a gradual fall toward the ocean! The nearest registry of rain to the Ramapo in New York is at Goshen, ten miles northwest of the Ramapo shed, but which registry the Ramapo advocate characterizes as "very imperfect measurements." That they are less reliable than rain records usually is an entirely gratuitous statement in his part, for Prof. Cooke in the Geology of New Jersey, 1868, thus speaks of them: "There are no records of similar observations ever made in that valley in our State. They were made at the Farmers' Hall Academy in Goshen, under the direction of the Regents of the University, and included in their publication of meteorological observations."

The rainfall is given for eleven years, and "the greatest annual fall was 40.45 in.; least annual fall, 25.62 in.; mean annual fall, 33.94 in., an average of 8 years."

Let the rainfall be what it may on the Ramapo shed—and its amount yet remains to be determined—nothing like the percentage of flow shown by the engineer of the Ramapo scheme as obtainable at Boyd's Corners can be counted upon either there or in the Ramapo district for each and every year. As before remarked, in this calculation we can have nothing to do with averages. We may speak of average rainfall, but when we come to the flow of the streams, which is the limit of available water, a flow of 15 inches during the entire year, which has occurred twice to our personal knowledge on the Croton basin, where the *average* rainfall is not less than 46 inches yearly, cannot be averaged with safety by seasons of great flow. The yearly flow of the Croton has been 74 per cent. of the rainfall, and as low as 36 per cent., and in the year of average rainfall for seventeen years (1877) the flow was 45 per cent., and this is taken as the estimated flow of the Croton basin, which, in an average year of rainfall, gives 21 inches as gatherable; but in a dry year of 38½ inches rain, such as 1880, it gives 17½ inches, while the actual measured flow that year gave but 15 inches, showing that even 45 per cent. of the rainfall is too high an estimate for a dry year's flow. And in projecting water-works for city supply it is regarded as the best practice of the day to recommend but 40 per cent. of the years of low rainfall as an estimate of all that can be relied upon from drainage areas having the general characteristics of the Croton and Passaic River basins.

What is said of the surface of the Ramapo shed being peculiarly favorable for collecting a larger proportion of the rainfall than usual, is only partly correct. It is true that an impermeable surface will deliver a larger proportion of the rainfall into the streams within a given time, but the discharges will partake more of the character of freshets, and soon expend themselves, without feeding the subterranean springs upon which dependence is placed for distributing the flow more equebly over a larger period of time, as is shown where deeper alluvia covers the bed rock; the total flow not being appreciably affected.

With reference to the lay of the respective vallies toward the direction of the prevailing rain-clouds from the ocean, Ramapo water-shed has no

advantage whatever over that of the upper Croton; which fact also may be inferred from the greater comparative rainfall of the latter valley.

As bearing upon this point, we quote from Professor Cooke who has for years past studied this subject (Geology of New Jersey 1876): "From these registers and their slight difference from each other, we may safely infer that the annual rainfall over all parts of New Jersey is nearly the same. The lowest observed annual rain is 27½ in. * * In most cases only about 40 per cent of the rainfall escapes in the streams, and we shall assume that 12 inches of the annual rainfall can be collected in streams and reservoirs, this being 40 per cent. of 30 in minimum rainfall nearly." and that this calculation is not *too great*, he refers to the measured flow from Lakes Hopatcong and Greenwood, which confirm it. The first-named lake, it will be remembered, is 915 feet above tide, and Greenwood is but seven miles southwest of the center of the upper Ramapo shed in New York, and allowing every conceivable advantage which can be claimed for the latter water-shed by reason of its superior elevation and assumed favorable surface for gathering rains, it would, in the absence of actual observations on the Ramapo shed, be a liberal estimate to allow *one-fourth* greater flow from the latter in years of minimum rainfall than is shown by observation at these lakes, a very few miles distant, and really differing too little in elevation to have any appreciable effect upon the rainfall. This would give less than 16 inches of yearly flow from the Upper Ramapo while the published reports as late as 1882 for Lake Hopatcong give rainfalls as low as 30 inches yearly from the shed of this lake, and for twenty-four years observations but an average of 42¼ yearly rain.

It may be accepted as a conclusion to which engineers have arrived that no system of reservoirs will be able to store the entire surplus waters from wet years; and hence, unless by allowing a liberal margin for contingencies, it is unsafe to calculate upon such surplus to make up the deficiency of successive years of low rainfall, which as we have lately seen may run through several years, as shown in 1878-79-80-81.

With reference to the extent of storage provided in the scheme, while the report of the Engineer gives a total of twenty-two reservoirs with a capacity of 17,000 million gallons, the instructions given to the Engineer to guide him in his plan for the supply of the first 50 million gallons limit him to eight of these natural ponds to be embraced in his first estimate, and in the absence of more definite details of the scheme, we have assumed that the capacity of these eight reservoirs is relied upon to furnish that amount.

As Mr. C. E. Smith, the Chairman of the Board of Underwriters' Committee very happily remarks, "that there were no expert engineers on the Committee, and that they simply applied *common sense* and their best judgment to the study of the question" we will be pardoned if we confine ourselves as far as our limited means extends, to the use of the same rare commodity.

The annual demand for water at 50 millions daily is 18,250 million gallons; 16 inches gathered in 40 square miles in the same time is 11,134 million gallons.

The deficiency of supply beyond demand is 7,116 gallons, and upon the supposition that the eight reservoirs named were full—total capacity, 6,210,000,000 gallons—and disregarding any unfavorable contingencies, this would show a deficiency of nearly 1,000,000,000 gallons for the year, and upon the supposition that two dry seasons occurred in succession, the possibility of which is indicated in the past, these ponds would prove wholly inadequate to keep up the supply. If it be said that the resources of the region furnish ample sites for artificial storage reservoirs to meet any demand, we can reply that it means CAPITAL, both for construction and management, not to mention time, in our judgment far beyond anything provided for in the scheme as presented to our notice.

PERSONAL.

JAMES AIKEN, formerly Ass't. Chf. Eng. of the Buffalo, N. Y. and Phila. R. R. died April 11, at Rochester, N. Y.

WM. H. VANDERBILT retired May, 4 from the immediate control of his railroad system, and has sailed for Europe.

A. DE GRAFF and WILLIAM CROOKS, railroad builders, of St. Paul, were in Minneapolis (Minn.) lately, in company with Engineer MCNAMARA.

H. D. BARTHOLOMEW, Civil Engineer, of Lansing, Mich., read a paper on "Drainage and Sewerage" at the Sanitary Convention held in Reed City.

HARRY MILLER, engineer of bridges on the Chicago, St. Louis & Pittsburgh road, Indianapolis Division, was lately married to Miss MAY BURBANK, daughter of ex-Governor BURBANK.

HENRY F. KNAPP, a civil engineer, is suing the Manhattan Beach Improvement Co. for $30,000 for work done to protect the strand at Manhattan Beach. A bill of particulars has been asked for.

JAMES WATERS has been appointed engineer of the Minneapolis (Minn.) Water Board at a salary of $3,500 per annum. He will have supervision of all improvements now in progress at the pumphouse.

W. H. ARMSTRONG, U. S. Railway Commissioner, is highly complimented by the *Railway News and Joint Stock Journal*, of London, for his intelligent and successful supervision of the Pacific railroads.

SELDON S. RICHARDS died at Atlantic City on May 7. He graduated from the Yale Scientific School, and was for a time Assistant Engineer on the Brooklyn Water-works; was lately a member of the New York Stock Exchange.

THE LATE JAMES O. MORSE C. E., for a long time treasurer of the Am. Soc. of Civ. Engineers, is said to have left a series of note books, giving a most complete history of the progress of engineering in this country for a period of forty years. Mr. Morse was in the habit of daily writing down observations and comments on any new departure in his profession, and kept most careful notes of all his own work.

It would be most interesting to the Civil Engineers of the U. S. to have these note books deposited in some accessible library, say that of the society, with which the author was so long and honorably connected. Who will unearth them?

PROFESSOR TROWBRIDGE delivered a lecture before the Engineering Society of the Columbia School ot Mines on "Modern Sanitary Engineering." The School of Mines gives the degree of Sanitary Engineer, and was the first institution to treat the subject of Sanitary Engineering as a distinct study.

ELECTIONS AND APPOINTMENTS.

BURTON KENT has been appointed City Engineer of Adrian. Mich.

L. W. CLARK was recently elected City Engineer of Stillwater, Minn.

J. W. HEVLMUN is appointed Chief Engineer of the Kansas City & Southern Railroad.

L. F. REINHARD has been elected Engineer of the Council Bluffs & Northern Railroad.

R. B. CABLE. has been appointed special superintendent of the Denver & Rio Grande, at $9,000 per annum.

CHARLES S. HENNINGS has been appointed Resident Engineer of the Atlantic & Pacific, at Coolidge, N. M.

L. S. COFFIN is appointed by Gov. Sherman, of Iowa, Railroad Commissioner to succeed James Wilson, elected to Congress.

A. L. STOKES has been appointed Superintendent of the Oregon Railway & Navigation Co. for the Pacific coast, headquarters at Portland, Oregon.

L. KIMBALL, formerly of the Pittsburgh, Cincinnati & St. Louis, has been appointed Superintendent of Bridges on the New York, Cincinnati & St. Louis Railroad.

HUGH SPENCER is appointed Superintendent of the St. Paul & Sioux City Division of the Chicago, St. Paul, Minneapolis & Omaha R. R., with office at St. James, Minn.

J. A. L. WADDELL, C. E., B. A., S. C., Ma. E., Professor of Civil Engineering in the University of Tokio, Tokio, Japan, has been elected Associate Member of the Institution of Civil Engineers of Great Britain.

J. E. CHILDS is appointed Assistant General Superintendent of the New York, West Shore & Buffalo Railroad from May 1. He was formerly General Superintendent of the New York, Ontario & Western Railroad.

THE NEW YORK CENTRAL, LAKE SHORE & MICHIGAN SOUTHERN and MICHIGAN CENTRAL, elected the following officers on May 4:

New York Central and Hudson River Railroad Company:

Chairman of the Board of Directors—Cornelius Vanderbilt.
President—James H. Rutter.
First Vice-President—Charles C. Clarke.
Second Vice-President—Chauncey M. Depew.
Third Vice-President—J. H. Hayden.
Assistant to the President—J. Tillinghast.
Treasurer—E. V. W. Rossiter.
Comptroller—Isaac P. Chambers.
Secretary—E. D. Worcester.

Lake Shore & Michigan Southern Railroad Company:

Chairman of the Board of Directors—W. K. Vanderbilt.
President—John Newell.
Vice-President, Secretary and Treasurer—E. D. Worcester.

Michigan Central Railroad Company:

Chairman of the Board of Directors—Cornelius Vanderbilt.
President—H. B Ledyard.
Vice-President—E. D. Worcester.
Treasurer—Henry Pratt.

NEWS OF THE WEEK.

THE CANADIAN PACIFIC.—Onderdonk, the contractor, has 4,000 Chinese, 2,000 whites and a number of Indians at work. Three million dollars have been already expended.

RAILROADS IN NEW MEXICO.—The Deming, Silver City & Pacific Railroad (narrow gauge) is almost completed from Deming to Silver City, a distance of ninety miles. It is proposed to extend it across the Gila River into the White Mountains, the Mogollon Mountains, etc., into Colorado and tap the Denver & Rio Grande Railroad. The road is the beginning of an extensive narrow gauge system which will rival that of Colorado.

NEW RAILROAD.—The citizens of Kingfield, Me., are urging the construction of a line between that town and New Portland. The preference seems to be to connect the road with the Sandy River road at Fairbanks. The gauge will be two feet. Three hundred and eight miles of the 764 miles of the through air line from Montreal to Louisburg, Cape Breton, are now completed, and 109 miles are building.

INSPECTING ELECTRIC LIGHTS.—A committee of the Chicago City Council recommended an ordinance authorizing the inspection of buildings lighted by electricity, and charging five dollars therefor.

A CONTRACT FOR IRON PIPE has been given by the Detroit Water Commissioners to the Cincinnati & Newport Iron Company for $42,000.

UNIFORM GAUGE ON SOUTHERN ROADS.—It is very likely that most of the Southern lines will soon adopt the standard gauge. It is said that since it has adopted the Northern gauge the Chicago, St. Louis & New Orleans has been constantly increasing its traffic, as Northern lines find it more convenient to deal with it.

THE SPRINGFIELD (ILLS.), STATE HOUSE.—A bill for submitting the completion and furnishing of the State House to the people has just been passed by the Illinois House. The appropriation calls for $531,712, and $25,000 are required for sidewalks. Similar bills have been hitherto defeated at the general elections.

THE FEORIDA SHIP CANAL CO. was organized at Washington on May 8. John C. Brown, Ex-Governor of Tennessee, is President, Hon. Wm.

Windom, Vice-Pres., Gen. Chas. P. Stone, Chief Eng. Gens. Butler and Mahone and Senator John P. Jones are among the Directors. $26,000,000 is the capital stock, so said. The work is expected to be under contract by September next, and the canal is expected to be finished in three years. The proposed route will leave the St. John's River about 20 miles above Jacksonville, and thence as near as possible in a straight line to the Suwanee River, on the Gulf, making a tide water canal 100 miles in length and deep enough to float the largest ocean steamer.

A NEW reservoir is being put in at the corner of Brush and Congress streets, Detroit, Mich.

THE Georgia Pacific system is being pushed forward rapidly, and trains will be run from Atlanta to Columbus in November.

A CONTRACT for sixty miles on the Georgia Pacific, between Birmingham and Columbus, will soon be let.

TWELVE locomotives have been ordered from the Baldwin Works by the Leopoldina narrow-gauge line (Brazil).

NEW CONSTRUCTIONS.—The U. S. Treasury Department has obtained grounds for its new building at Fort Wayne (Ind.) and operation will begin in a few days.

FEMALE LABOR.—Girls at 50 cents a day are employed to load and wheel barrows by an Illinois tile works. This is rough on the fair sex, although contractors might appreciate "fair" labor and low wages.

GASOLINE STREET LIGHTING is to be introduced in Quincy (Ills.). It is claimed that 500 lights can be provided at an annual expense of $7,000.

ELECTRIC LIGHTING FOR ASYLUMS.—The board of trustees of the Rochester (Minn.) Insane Asylum, believes that electric lighting would lessen the danger from fire.

LAREDO (TEX.) WATER-WORKS were recently commenced by Mr. Hill, of New York. They must be finished by August 18, or franchises will be lost. The outlay is $75,000. A bridge is also to be built across the Rio Grande.

STREET RAILWAYS.—Gainesville (Tex.) wants them.

NEW BRIDGE COMPANY.—A company with a capital of $50,000 has been incorporated, for the purpose of building a bridge over Mission Bay (Cal.) and charging tolls for use of same.

THE PERMANENT BRIDGE across the Rio Grande at Eagle Pass, was recently opened with appropriate ceremonies, and the builder, R. G. Reed, was presented with some costly Mexican hats.

A CORPS OF ENGINEERS are surveying the Jackson River to the head waters of the Ganley in West Virginia, for the purpose of extending the Richmond & Alleghany Railroad so as to connect with the Pittsburg Southern.

A LOST CONTRACT.—A Chicago contractor who undertook to build a dry dock at Albina for the Oregon Navigation Co., has failed to carry out his contract, and the company has taken it off his hands.

DIGGING UP THE STREETS will not be permitted in St. Paul, and City Engineer Somers is to draft an ordinance to that effect.

ADVANCE FUNDS ARE ILLEGAL is the opinion of the Corporation Counsel of Chicago. The amount of money appropriated for street improvements is some $90,000 short, and some citizens were willing to advance the deficiency and have the works proceeded with. The legal provisions against borrowing are, however, very strict. The laws, however, do not include contracts for large public buildings which may require more than one year for their completion.

CAPT. KNAPP has commenced the government work at Mile Island (Minn.), up the St. Croix. He is completing a dam which was begun last season.

BIG TRAINS.—A passenger train of the Pittsburg, Fort Wayne and Chicago lately arrived in four sections. The first section carried nine cars of passengers; the second had thirteen cars of tobacco; the third had eight loaded sleepers, and the fourth brought twelve car-loads of emigrants, making a total of forty-two cars, which is decidedly above the average number.

A SURVEYING PARTY under the command of Col. Whelan has been organized at Fort Ellis (Montana). They are to survey a road from Billings up the valley to the National Park.

NEW PARK.—The citizens of Dubuque (Ia.) wish the Town Council to buy the old fair ground, containing ninety acres, and convert them into a public park.

MINNEAPOLIS PARK.—The Park Commissioners will consider the purchase of more ground for park purposes. H. W. S. Cleveland, of Chicago, addressed the Commissioners on the best methods of establishing parks, etc. He said that the great trouble is that the movement for parks is delayed until the rapid growth of cities makes land very valuable. He favored the practice of selecting low or comparatively worthless grounds for parks and reverted to Paris in illustration, where abandoned stone quarries and unsightly localities had been taken and converted into beautiful or picturesque parks. He commended the site of Central Park, so far as he had examined it. Wide driveways on either bank of the river were recommended, and long, broad streets with garden spots running along the centers.

NEW RAILROADS.—Certain capitalists propose to build a direct road from Matamoras to Montery ....A branch line of the New Orleans, Baton Rouge, Memphis & Vicksburg Railroad is to be built from Greenville, Miss., to a point in Sharkey Co. It will be forty miles long; contracts for construction will be let next month, and the line completed before January 1, 1884....Work is progressing on the Springfield and Southern narrow gauge railroad....The Minneapolis, St. Paul & Seacoast Railway has been incorporated, capital $15,000,000. The road is to be run from Minneapolis via St. Paul to the Southern boundary in Fillmore County and the Mississippi River at Canton, Ia. ....Thomas M. Nichol has been visiting Fort Scott, Kansas, projecting a new railroad....Surveys for the extension of the Union Pacific to San Francisco will be soon begun at Salt Lake....*The Tehuantepec Railway.*—Three more miles of line have been completed at the Gulf end of this railway, making a total of 28 miles now constructed....A narrow gauge road from Dubuque, Ia., to Dakota is projected. Diamond Jo Reynolds and Chicago capitalists are interested in it....A line of 235 miles from Bismarck to the Black Hills is under discussion.

FIFTEEN HUNDRED laborers are at work on the Mexican Central. Rapid progress is made on the Pacific branch.

CONTRACTS AWARDED.—The St. Paul Board of Public Works awarded contract for grading Oak street to J. J. Palmer for $4,433.

THE PROPRIETOR OF THE WATER-WORKS at Kendall, McKean County, Pa., was hanged in effigy lately for refusing to supply the town with water while several buildings were on fire.

STOPPAGE OF ROAD BUILDING.—Under the agreement between the Atchison, Topeka & Santa Fé, the St. Louis & San Francisco and Atlantic & Pacific, the latter is to stop the construction of its line west of the Colorado River, but will eventually be allowed to reach San Francisco.

THE SITE FOR THE PUBLIC BUILDING at Lynchburg (Va.) was lately inspected by Major Hill, Chief Architect of the United States Government.

SALE OF THE WASHINGTON & WESTERN RAILROAD.—This road was sold on Wednesday, at Alexandria (Va.) for $400,000. The purchasers were Bates & Oakman, representing the Oak Ames and McComb interest.

A REMEDY FOR BURNS AND SCALDS.—It is now many years ago, says Mr. F. Peppercorne, in the *Popular Science Monthly*, while engaged in some investigations as to the qualities and effects of the alkalies in inflammations of the skin, etc., that he was fortunate enough to discover that a saline lotion, or a saturated solution of bicarbonate of soda in either plain water or camphorated water, if applied speedily, or as soon as possible, to a burned or scalded part, was most effectual in immediately relieving the acute burning pain; and when the burn was only superficial or not severe, removing all pain in the course of a very short time; having also the very great advantage of cleanliness, and, if applied at once, of preventing the usual consequences—a painful blistering of the skin, separation of the epidermis, and, perhaps, more or less of suppuration. For this purpose all that is necessary is to cut a piece of lint, or old soft rag, or even thick blotting paper, of a size sufficient to cover the burned or scalded parts, and to keep it constantly well wet with the sodaic lotion so as to prevent its drying. By this means it usually happens that all pain ceases in from a quarter to a half an hour, or even in much less time. When the main part of a limb, such as the hand and forearm or the foot and leg, has been burned it is best, when practicable, to plunge the part at once into a jug or pail or other convenient vessel filled with the soda lotion and keep it there until the pain subsides, or the limb may be swathed or encircled with a surgeon's cotton bandage previously soaked in the saturated solution and kept constantly wet with it, the relief usually being immediate, provided the solution be saturated and cold. What is now usually sold as bicarbonate of soda is what he has commonly used and recommended, although this is well known to vary much in quality according to where it is manufactured, but it will be found to answer the purpose, although probably Howard's is most to be depended on, the common carbonate being too caustic.

SEWER SURVEYS.—The plans made for the Fullerton Co. sewer (Lake View, Ill.) not being satisfactory to some parties they have petitioned the council to have three engineers report on the matter.

RAILROAD ECONOMY.—The New York & New England Company has discharged 175 of the 200 men employed in improving its rolling stock.

NEW RAILROADS.—The Lake Superior & North Western Railroad has been organized at Duluth (Minn). The main line is to run from Duluth in a northwesterly direction to the mouth of the Red Lake River, with branches from a line west of the Mississippi to the northern boundary of the State, and from same point to Brainerd; third branch from Duluth via Vermilion to the northern water boundary of the State, and fourth from Duluth along the north shore to Pigeon River. The capital is $5,000,000.

Grading is to be commenced immediately on the Carrington branch of the Northern Pacific to Sykesville. As soon as the grading has been completed, the construction of the Mouse River road from Carrington will be commenced.

Work has been commenced on the Selkirk & Winnipeg branch of the Canadian Pacific. Marsden & Co., the contractors, proposing to have the branch ready for track laying June 1.

BRIDGE LETTING.—J. W. Shipman, of New York, representing the Wrought Iron Bridge Co., of Canton, O., last week secured the contract for the La Grange, Tex., bridge, at $38,000. Five bridge firms competed, and one bid was lower in price than Mr. Shipman's.

THE HOOSAC TUNNEL.—The Governor of Massachusetts refused to sign the resolution appropriating $264.552 for double-tracking the Hoosac Tunnel line.

CONTRACT AWARDED.—The contract for building the Columbus & Eastern Railroad between Columbus and Moxahala, Perry Co. (O.) has been let to C. H. Roser & Co., of New York. The distance is about 60 miles, and must be ready for the rails by Oct. 1.

A BIG LOCOMOTIVE.—The Pittsburgh, Fort Wayne & Chicago shops at Fort Wayne have turned out a new locomotive of the class I, which is one of five to be built. It is a consolidated engine, weighing 97,000 pounds and has four drivers on each side. It hauls sixty car-loads of freight.

AN OLD MINE REDIVIVUS.—A letter from Texas states that machinery is being made to pump out and work the old mine near Guanajuato, Mexico, which, according to Humboldt, is the richest mine on this continent, having yielded over $100,000,000. The mine has been full of water since the expulsion of the Spanish, eighty-three years ago. Most of the owners are residents of Mexico.

RAILROAD EXTENSION.—The Chicago, Burlington & Quincy are trying to have an extension to Utah.

THE MISSISSIPPI LEVEES.—The Governor of Louisiana has called a convention to meet in New Orleans, June 18, for the purpose of devising better measures for maintaining, repairing and building the levees.

NEW BRIDGE.—The New York & Canada Bridge Co. has been authorized to build a bridge over the St. Lawrence River from Waddington to Ogden's Island.

SELECTING A CAPITAL.—The politicians of Dakota are outbidding one another for the capital of the Territory. The town of Mitchell offers $200,000 and 400 acres of land; Ordway, $300,000 and a section of land, and Huron, $150,000 and half a section.

WHY HE FAILED.—It is said that Mr. Bates in trying to build a dry dock at Albina made no calculation for the nature of the ground, which is low and has a tendency to cave in.

WATER-WORKS.—The citizens of Faribault (Minn.) are urging the necessity of having water-works in that city, and the council is requested to move in the matter....A meeting of citizens of Watertown (Conn.) was recently held to consider a water supply for the town and to have the advocates of the Holly, Newtown and reservoir systems unite. The Newtown scheme was finally adopted. A sum of $125,000 will probably be expended in laying pipes. A public meeting will soon be held. ....About 150 men are now at work on the new basin of the Boston water supply at Ashland. The cost of excavating during the year will be about $100,000....The new water-works are now in operation at Richmond (Va.). The whole cost is placed at $900,000. The old works will be sold or perhaps utilized for electric lighting....Work on the new water-works at Wakefield (Mass.) has been begun. A large number of Italians are employed....The total capacity of the old and new pumps of the Minneapolis water-works is now 13,000,000 gallons per day, which will be increased to 23,000,000 gallons when the second pump is added....The Legislative Committee on Water Supply, etc., lately visited Lynn (Mass.). The tubular wells were first visited. The pumping station, the reservoir, the storage basins, the lake at Wakefield were successively visited. The definite plan of the city is to take the surplus water from Pranker's Mill Pond, which now runs over the dam at the rate of

20,000,000 gallons daily, and sometimes 25,000,000 gallons. The water from this dam would not flow into Birch Brook, but it would flow into the pumping well at the engine-house, the fall being two feet.

CHICAGO CONTRACTS.—The bids for constructing the proposed sewers in Chicago were as follows: South division, No. 1, to McNichols & King, $3,593.10; West division, No. 2, McNichols & King, $5,986; West division, No. 3, John Lyons, $4,275.87; West division, No. 4, McNichols & King, $3,805.64; North division, No. 5, Thomas McQueney, $4,442.05. The principal work for this year will be the completion of the large sewers on Twenty-second and Wallace streets. Main outlets will be constructed as follows: Indiana street, from Milwaukee avenue to the river; North avenue, from Wood street to Milwaukee avenue; Milwaukee avenue, from North avenue to the city limits; Laurel street, from Thirty-fifth to Thirty-eighth street; Robey street, from Twenty-second to Nineteenth street.

RAILROAD BUILDING.—The Chicago *Railway Age* gives the following statistics of railroad building during the first four months of the year: 1,450 miles of main track were laid, as against 2,300 miles same period last year. The decrease is attributed to the cold winter weather. The work was done on 75 different lines in 31 States and Territories, principal among which were: California, 170 miles; Utah, 156; New York, 115; Pennsylvania, 93; Montana, 86; Idaho, 85; Arizona, 84; and Missouri, 73. The estimated building for this year is 8,000 miles....The Erie and Wyoming line has been surveyed from the North, and it is thought that a connection with the Pennsylvania Railroad over the canal bed is contemplated.... An English syndicate has agreed to advance capital for building the Ottawa, Waddington & New York Railway. The line will save 85 miles between Ottawa and New York....Orders have been issued by Henry Villard to begin work on the Westside road, from Corrwallis to Junction City (Or.), a distance of 25 miles....Sir C. Tupper stated at Ottawa that the Government had expended on the Thunder Bay and British Columbia sections of the Canadian Pacific, exclusive of surveys, $28,140,883. The company estimate that they will expend $11,000,000 in branch lines in northwest....The Waterloo & Carondelet Railroad Co. has been incorporated at Springfield (Ill.) with a capital of $100,000....Arrangements have been made for rapidly pushing on the Baltimore & Ohio Railroad's line between Baltimore and Philadelphia.

WOMEN SPOTTERS UNDER A CLOUD.—For some weeks past women spotters have been working on the New York Central road, but a blunder of one of their number has done much to place them under a cloud. These women detectives are provided with note-books and ingenious little mirrors by which, with their backs turned to the conductor, they can see just how many passengers on a coach give up tickets or money for fares. The veil and wraps worn by them readily conceal their movements and disarm suspicion. "A few days ago," says the New York *Tribune*, "one of these spies got on a train going to Utica. She took one of the front seats in a coach, and was seen to keep her hand to her face and peer into a little box which contained two mirrors set at angles, so as to reflect all movements made behind her. The honest conductor passed through the coach, collected tickets and received money, giving, as he always does, a punched duplex ticket as receipt for fare. After he had left the coach, the woman responded to the flirtations of a drummer who had noted her performance and wished to have some fun. The woman received his attentions cheerfully, and made room for him to divide her seat with him. The drummer was persistent in his attention, and succeeded in inducing her to leave the train with him at one of the stations. Before he did this he succeeded in reversing her jacket pocket so that the little mirror, note-book, her instructions in her trade, schedule of fares and other articles of her trade fell on the coach seat. The train passed on, and the 'spotter' did not miss her 'kit' until it was too late. The train-boys had captured the articles."

THE RAIL MARKET.—Steel rails, prices are steady at about $39 per ton at mill for summer delivery, with few new orders reported. Some orders for fall have been placed at $38. Light rails in fair demand and are quoted at $40 to $43, according to section.

Rail Fastenings.—Spikes are unchanged at $2.60 per 100 lbs. in Pittsburgh, with a more active demand. Track-bolts are still quoted at $3.25 per 100 lbs. for square nuts and $3.35 to $3.45 for hexagon nuts. Splice bars are a shade lower at 2 cents per pound.

Old Rails.—The market for old iron rails is dull and quotations nominal at $23.50 to $24.50 per ton at tidewater for tees, and $27 for double-heads.

NEW CONSTRUCTIONS.—The Turners of Bloomington (Ills.) are to have a new $10,000 hall. The combination bridge over the Zumbro near Kellogg (Minn.) is to be built by H. E. Horton for $3,295. The contract for the new court-house at Long Prairie (Minn.) was awarded to John Eaton for $20,000. Bellow Falls (Vt.) is to have a new town-house at a cost of $12,500. The committee have decided that the work of rebuilding the Warren (Mass.) bridge, for which an appropriation of $480,000 has been made, shall be done by day labor instead of by contract.

THE PLANT INVESTMENT COMPANY has purchased a controlling interest in the South Florida Railroad, extending from Sanford to Kissimmee. The road will be completed immediately to Tampa Bay. New York parties will run a line of steamships from Tampa to Havana.

A LARGE DREDGE.—The Okeechobee Co. will launch on May 14 the dredger "President Arthur;" its capacity is said to be be 20,000 cu. yds per day. It is intended to cut a canal 65 ft. wide and 10 ft. deep from Lake Kissimmee to Lake Okeechobee. It is expected to reclaim 4,000,000 acres of sugar land by this process.

THE DUTCH EXPOSITION was opened at Amsterdam on May 1, and will continue until Oct. 1.

THE HAMMERSMITH BRIDGE, London, is practically to be reconstructed by the alterations authorized by the Act of the House of Commons of April 24.

HUGE ANVIL BLOCKS.—An 170-ton anvil block was cast in April at the Dalziel Steel Works, in England; it is to be used with a 12-ton hammer in a Scottish steel works. Another, to weigh 165 tons, is in progress at the Govan Forge & Steel Co.'s Works at Glasgow. Mr. Wm. Ireland, who has in charge the making of this latter block, has already superintended the casting of five blocks, of 175 tons each, for the Union Company of Dortmund, and one block, of 250 tons, for the Osnabrück Steel & Iron Company.

THE METRIC SYSTEM IN HAVANA will be made obligatory by law from July 1 next.

WORK ON THE WASHINGTON MONUMENT was resumed May 7, and before the season closes it is expected to add 100 ft. to the present height of 320 ft.

THE MERCEDE CANAL, intended to irrigate the San Joaquin Valley, Cal., is being rapidly pushed forward; 250,000 acres of land are to be reclaimed by this scheme.

AN ELECTRIC RAILWAY CO. IS CHARTERED by the State of New York. Thos. A. Edison and others are the incorporators, capital $2,000,000. S. G. Reed of Portland, O., is Prest., Stephen D. Field, Electrician. Mr. Reed is supposed to represent the interest of Henry Villard of the N. Pac. R. R. Cyrus W. Field is said to be one of the capitalists.

THE FIRST ENGLISH-BUILT BRIDGE OF TRUE AMERICAN TYPE has just been finished at Gateshead, England. It is an iron pin-connected bridge, of one 315-ft. span and two 105-ft. spans from the design of C. C. Schneider, C. E., of New York, and intended for the crossing of the Frazer River in British Columbia.

THE CONSTRUCTION OF THE SAULT STE. MARIE BRIDGE seems to be assured. The Canadian Parliament and the Michigan Legislature both granted charters at their last session. The bridge will be 3,900 ft. long and will cost about $850,000.

THE PENNA. R. R. DOUBLE TRACK is to be at once commenced on all important lines west of Pittsburgh, the line between Crestline, O., and Chicago to be double-tracked this season, and 20 miles of double-track to be added to the Pittsburg, Cin. & St. Louis.

FREE PASSES IN NEW YORK STATE are forbidden by the Act of Assembly, passed May 4, to any except railroad employés and officers of the companies.

N. PACIFIC R. R. STATIONS RE-NAMED.—General Passenger Agent Barnes of the Northern Pacific, issued a circular making the following changes in names of stations on that road:

Dakota Division—Clarke changed to Menoken.

Missouri Division—Bly's Mine changed to Sims; Houston changed to Bellfield; Fogarty changed to Fryburg; Keith changed to McClellan; Kendrick changed to Hodges.

Yellowstone Division—Coal Bank changed to Hathaway; Rimrock changed to Park City.

The following are new stations:

Fergus Falls Branch—Parkton, first station west of Deer Creek; Ellsworth, first station west of Wahpeton; Griffin, second station west of Wahpeton; Barney, third station west of Wahpeton; Wynkmere, fourth station west of Wahpeton.

Missouri Division—New Salem, first station west of Sedalia; Glenullen, first station west of Kurtz; Richardton, first station west of Antelope.

Montana Division—Stations west of Livingston are as follows: Coal Spur, Muir, Summit, West End, Tie Spur, Elliston, Bozeman, First Siding, Second Siding, Gallatin.

THE Central Pacific R. R. has 3,000 men at work on the Oregon Division. The Southern Pacific has begun the construction of a branch line from Aplos to Loma Prieta, the top of the redwood forests.

THE Fort Scott & Wichita R. R. has been completed to a point 130 miles west of Fort Scott. One hundred and thirty miles more will bring the road to Wichita.

DARDANELLE & RUSSELLVILLE RAILWAY is a four-mile branch of the L. R. & F. S. Ry, starting at Russellville and ending on the Arkansas River, opposite Dardanelle. It is being built by an independent corporation. Contracts have been let to J. F. Moore & Co., and the road will be completed by August 1.

STOPS TO KISS HIS WIFE.—On two occasions I have witnessed brakes whistled down and a train-load of passengers stopped in the pine woods, while the conductor slowly ambled off to a neat cottage in a little orange grove and kissed his wife and a large family of children ranged along on top of the fence. I think it was his wife, but there was some speculation in regard to it.—*Florida letter in Chicago Inter-Ocean.*

IRON AND METAL MARKET.

PHILADELPHIA, MAY 11.

The iron market in Eastern Pennsylvania has not improved as was looked for. The reason for the dullness in prices and demand is ascribed by most manufacturers and brokers to the uncertainty as to a suspension in the West. Should there be a suspension, demand and prices East will improve, and buyers will purchase for summer requirements as soon as they are assured of it. Numerous inquiries are in the market and requirements have been made known, but no possible concessions can induce buyers to act. No. 1 foundry iron has been offered as low as $21.50, and special brands are selling slowly at $22@$22.50. No. 2 iron is $2 below this figure, but very dull. Mill irons are very dull at prices ranging all the way from $17@$19 at furnace, and transactions show that $18 is the average for standard makes. A few hundred tons of muck bars were ordered for June delivery at $34 at mill. Car-load lots of nails have been ordered at $3, and jobbers' lots are moving with activity at $3.20. Construction iron continues quiet, and as soon as the market settles large orders will be placed for summer and fall delivery. Nothing new has taken place in steel rails, but constructive requirements are large, and orders will be placed in June for fall and winter delivery, provided prices are acceptable to buyers. Old material is without activity and has advanced 50 cents. Quotations are $24@$28.

PITTSBURGH.

There are efforts in progress looking toward a renewal of negotiations between employers and workmen in the mills with a view to a compromise. Neither side is anxious for a strike apparently, but on the part of the manufacturers they are willing to see a restriction provided it can be inaugurated by the workmen. Merchant iron is selling at 2c. If full production is maintained prices will decline below this figure. Nails are in active demand at $3, and at a recent meeting of the Nail Association it was concluded to continue production at maximum out-put. Steel rails are selling in small lots at $40. In view of the strike to take place June 1, forge iron is in very dull request and foundry is moving in small lots for immediate requirements. Prices are ranging from $17@$19 for forge, and $20@$22 for foundry. The situation in Western Pennsylvania is unsatisfactory because of the uncertainty as to production and the probability of strikes. Should another meeting take place, it will probably be held in ten days, but at present writing no amicable solution is probable, as it is to the interest of manufacturers to see a restriction brought about.

CINCINNATI.

A few large transactions in charcoal iron have been closed at very low prices. Stocks are large, and producers are unwilling to hold over the summer. Merchant iron has been in more active demand for a week past in consequence of possible suspensions. Forge iron is weak and stocks are large. The output of nails is heavy, and assortments are much broken up in meeting demands for building purposes. Southern iron is in large supply, and prices are inclined to weakness.

ST. LOUIS.

The Missouri market has been more active for the past two weeks than for two months. The labor troubles in the St. Louis mills have been finally settled by the disbandment of the labor organizations, and work has been resumed in all of the mills. A fair amount of business is in hand, and it is quite possible that there will be no further trouble this season, either in the way of strikes or in demand for iron.

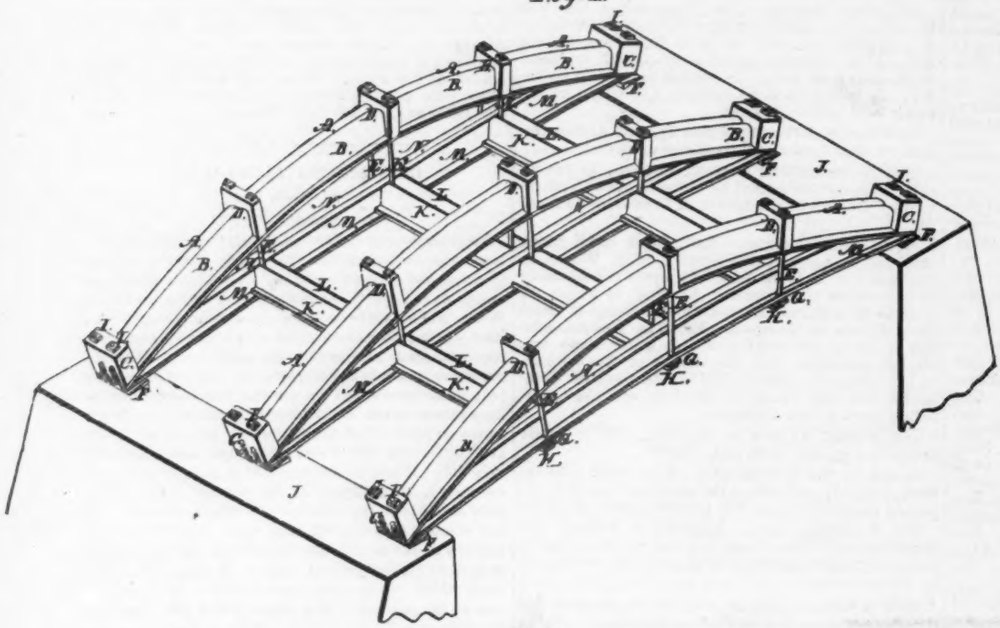
TRUSS BRIDGES.

AN ILLUSTRATED HISTORICAL DESCRIPTION OF ALL EXPIRED PATENTS ON TRUSS BRIDGES, WHICH UNDER THE LAW ARE NOW PUBLIC PROPERTY AND FREE TO BE USED BY ANY ONE.

By F. B. Brock, Patent Attorney, Washington, D. C.

A perspective and sectional view is shown of a truss bridge patented by Richard Montgomery of New York, August 23, 1859. It was reissued November 1, 1870, and expired August 23, 1873.

Fig. 1.



MONTGOMERY'S TRUSS.

A single span is shown resting upon two abutments, and consists of three parallel systems of combined arches. Each of these systems of arches is composed of one arch *A B* on top, and another arch *M N* of larger radius below the first one. *F* are bed-plates having vertical projections which fit into the bottom part of the corrugations of the arches *M*, and blocks *C* are provided with recesses so as to fit over the corrugations. Bolts *I* pass through the blocks *C*, arches, and bed-plates into the abutments. *D* are blocks, equal distance from each other, shaped in such manner as to fit over the corrugations of the upper arches, and having also a corrugated bottom plate *G* adapted to the contour of the lower arches *M*, the plates being, in fact, similar to the bed-plates *F*.

Suspension bolts *E* pass through blocks *D*, the flanges of both arches, and through the plates *G*, the bolt-heads being below said plates.

The three systems or arches shown in the cuts are united by cross rails *L K*, which are also corrugated similar to the arches. These rails rest with their ends upon the flanges of the lower arches immediately above the bottom plates, the bolts *E* passing through their ends so as to support them, and in which position they support the flooring.

Fig. 1 represents an elevation of the Van Duzer arch; and Figs. 2 and 3 are enlarged views in detail of the arch stones and gripping devices.

Fig. 2.

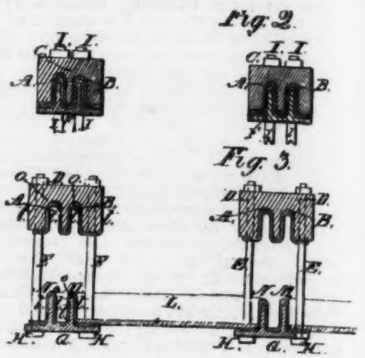
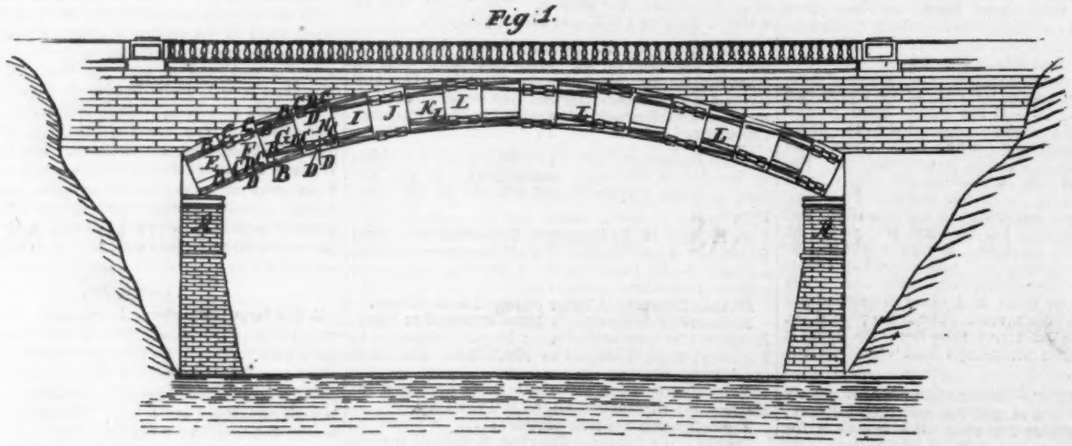


Fig. 3.

The blocks or arch stones are wrought of usual tapering form. *B* represents iron rods placed near the upper and lower part of the stones, or near the intrados and extrados of the arch, others may placed between these as occasion requires.

These rods are for the purpose of sustaining the arch stones, and must necessarily be made of sufficient size, adapted to the strength and span of which the arch is to be made. The rods *B* also have angular or T blocks *C* on their ends, through which pass two screw-bolts *D D*. These bolts are provided with nuts *a* for lightening up the arch stones in the following order: The spring stone *E* rests upon the abutments. The rods *B* start from this stone and extend to the third stone *G*, the connection of the rods being made by

Fig. 1.



VAN DUZER BRIDGE.